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EFFECTS OF FENUGREEK (TRIGONELLA FOENUM-GRAECUM L.) ON HYPERANDROGENIC ANOVULATION AMONG YOUNG FEMALES

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ABSTRACT
Obesity, insulin resistance, hormonal disorders, dyslipidaemia and menstrual disorders are some of the common comorbidities associated with metabolic and reproductive disorders. Any positive intervention that will have a positive impact on metabolic and reproductive health is very significant to decrease disease burden and improve quality of life. The aim of this study was to assess the effect of this intervention on body mass index (BMI), reproductive hormones (follicle-stimulating hormone [FSH] and luteinizing hormone [LH]), glycemic control (HbA1c), lipid profile, and menstrual cycle regularity throughout the 60-day intervention. The method used in the study was a Comparative Interventional Study, which comprised three groups: the control group, the first experimental group, and the second experimental group. The levels of FSH, LH, HbA1c, total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglycerides, and menstrual cycle characteristics were measured prior to and after intervention. One-way ANOVA and Kruskal-Wallis statistical analysis were used to analyze the data, with a significance level of $p < 0.05$. Results: There were no differences in baseline characteristics between all of the study groups. The BMI in the Experimental Group 2 was the lowest and was statistically different from the other three groups ($p = 0.006$) after the intervention. In addition, there was a significant rise in triglycerides ($p<0.001$) and HDL ($p<0.001$), and the regularity of menstruation rose the highest in Experimental Group 2 (65.2%) and lowest in the same group (8.7%) in terms of amenorrhea. The treatment led to a decrease in levels of FSH, LH, HbA1C, total cholesterol, and LDL cholesterol that were not statistically significant ($p>0.05$). Overall, the intervention was beneficial for the different metabolic and reproductive parameters, especially for Experimental Group 2. The results show a positive influence of the intervention on the regularity of menstruation, BMI, triglycerides, HDL, and reproduction (in a positive direction). The hormonal and glycemic parameters were not significant, but the results allow consideration of potential clinical advantages that need to be investigated. Future research with longer follow-up is suggested to validate the present results and to assess the long-term impact of the intervention.

KEYWORDS: Menstrual Cycle, Reproductive Health, Metabolic Health, FSH, lipid profile, triglycerides, BMI.

INTRODUCTION
Polycystic ovary syndrome (PCOS) is a common endocrine and reproductive disorder that is characteristic of women of reproductive age and is characterized by hyperandrogenism and anovulation (Gul et al., 2024; Afzal et al., 2026). It is associated with excess androgen, irregular periods, low anovulation and follicular development, and causes various metabolic problems (Merdana et al., 2025). The prevalence of PCOS is estimated at 8-13 % of women of reproductive age (19-40 years) worldwide, and this may be influenced by the diagnostic criteria and the populations being studied (Patel, 2018). One of the most common reasons for female infertility is often related to obesity, insulin resistance, dyslipidaemia, type 2 diabetes mellitus, cardiovascular risk, anxiety and depression (Naeem et al., 2025; Qamar et al., 2025). Adolescent and young females have undergone substantial changes in lifestyle and dietary habits, which have resulted in PCOS being a public health problem, especially in the developing world, and is also linked to the rampant growth of metabolic diseases (Wang et al., 2025).
Hyperandrogenism is a disorder that is characterized by anovulation. An excess of circulating androgens interferes with normal follicular maturation and halts growth of the follicles, thus preventing ovulation (Wang et al., 2023). Furthermore, insulin resistance, which a significant number of women with PCOS suffer from, worsens

hyperandrogenism by activating androgen production from the ovary and decreasing the amount of sex hormone-binding globulin (SHBG) produced by the liver (Xu & Qiao, 2022). This hormonal imbalance between the hypothalamus, the pituitary, and the ovary alters the hormones secreted by the pituitary (luteinizing hormone - LH and follicle-stimulating hormone - FSH) and may result in menstrual irregularities, infertility, acne, hirsutism, and hair loss (Turki & Ammar, 2024). Chronic low-grade inflammation and oxidative stress are common and are also associated with these reproductive aberrations and contribute to additional damage to the ovary and metabolic homeostasis (Orisaka et al., 2023).

Lifestyle modification, weight loss, and combined oral contraceptives, anti-androgen medications, insulin-sensitizing agents (e.g., metformin), and anti-androgen medications used to stimulate ovulation (e.g., letrozole, clomiphene citrate) are used in the treatment of hyperandrogenic anovulation (Ni et al., 2025). These treatments have resulted in good response in numerous patients with the disorder but can have side effects, may not be well tolerated in the long term, or may not address the multi-factorial nature of the disorder (Jogna et al., 2025). The gastrointestinal side effects, hormonal side effects, recurrence of symptoms after treatment, and loss of adherence by the patient are the drawbacks of current pharmacologic treatment (Carvalho et al., 2016). Therefore, the interest in complementary and alternative therapies (C.A.T.), especially medicinal plants with scientifically proven pharmacological properties that could be used as a safer and sustainable therapy, has grown (Manisha et al., 2025).

One among the above-mentioned medicinal plants of great interest is fenugreek, Trigonella foenum-graecum L., which has several therapeutic properties (Singh et al., 2022). Fenugreek is an annual herb of the family Fabaceae and has been a part of traditional medicine systems such as Ayurveda, Unani and Traditional Chinese Medicine for many years (Arunabha & Bhattacharjee, 2019). The seed contains a high amount of several biologically active constituents such as steroidal saponins (particularly diosgenin), amino acids (4-hydroxyisoleucine), alkaloids (trigonelline), flavonoids, galactomannan fiber, vitamins, minerals and a few phenolic compounds (Akhtar et al., 2025; Ullah et al., 2025). These phytochemicals (e.g., antioxidants, anti-inflammatory, hypoglycemic, hypolipidemic and endocrine-modulating) give fenugreek an interesting potential as a natural source for the treatment of metabolic and reproductive diseases (Alu'datt et al., 2024; Kanfon et al., 2025; Rai et al., 2025).

Hormone modulation, glucose metabolism regulation, insulin sensitizing, and antioxidant activity are the primary mechanisms by which fenugreek has been shown to have a therapeutic effect in hyperandrogenic disorders in women (Nagulapalli Venkata et al., 2017). Experimental and clinical studies have revealed that fenugreek supplementation leads to the improvement of menstrual regularity, reduction of ovarian volume, reduction of the number of cysts, reduction of free testosterone levels, and improvement of metabolic markers such as fasting blood glucose, lipid profile, and insulin resistance (Singh et al., 2023). Additionally, some randomized clinical trials have noted improved hirsutism, menstrual disorder, and LH and FSH levels in women with PCOS after consuming fenugreek seed extracts (Krishnan et al., 2026). From these results, it can be concluded that fenugreek has the potential to influence various processes such as endocrine regulation, enhancement of antioxidant defence, and metabolic improvement (Srinivasan, 2006).

This is especially relevant in young females as disruption of hormones at this time in life could have long-term effects on reproductive health, fertility and long-term metabolic consequences (Bala et al., 2021). Hyperandrogenic anovulation can be effectively treated and managed at an early stage to prevent disease progression and reduce the risks of disease complications, such as cardiovascular disease, type 2 diabetes, metabolic syndrome and infertility (Marciniak et al., 2016). In addition, since many young women are interested in using natural or alternative therapies for fear of the side effects of extended hormonal use, it is significant to look into studies of the effectiveness of herbal remedies (Gentry-Maharaj et al., 2015; Rueangsri et al., 2025). Fenugreek, being cheap, easily accessible, and well tolerated, may be a potentially accessible therapeutic option, but needs to be backed by scientific research and not just traditional use (Yao et al., 2020).

Although some promising results have been observed in previous studies, there are still some gaps in understanding the clinical efficacy of fenugreek in hyperandrogenic anovulation, especially in young females (Akhtari et al., 2024; Suthar, 2025). Most published studies have made general statements about PCOS; instead, hyperandrogenic anovulation and the underlying hormonal and metabolic processes have been poorly studied. Furthermore, the direct comparisons between studies are limited due to variations in study design, dose, treatment duration, and formulation (Nadeem & Farooq, 2025). Further clinical trials should be well designed to set standards of treatment and establish the use of fenugreek as an adjunct/alternative in the treatment of reproductive endocrine disorders.

Hence, the present study is planned to study fenugreek in hyperandrogenic anovulation in young females with respect to the reproductive hormones, ovulatory function, menstrual regularity, and certain metabolic parameters. The results of this study will add to the accumulating evidence of the use of scientifically validated medicinal plants in reproductive health and could offer a safe, inexpensive, and effective complementary approach to improving the reproductive and metabolic health of affected young women with hyperandrogenic disorders.

MATERIALS AND METHODS

Place of Study

In the present randomized controlled trial (RCT) conducted at Punjab Medical Center, Jail Road, Lahore, all the participants were recruited, and clinical assessments, follow-up visits, and laboratory investigations were carried

out. The clinic provides services for gynecological consultations and tests, and anthropometric assessment equipment for the study.

Study Design

The aim of this study was to assess the effects of fenugreek (*Trigonella foenum-graecum* L.) seed powder in young females diagnosed with hyperandrogenic anovulation (HAN) in a randomized controlled trial (RCT) design. The whole study took 9 months, which included recruitment, intervention, follow-up, data collection, and statistical analysis. The intervention time was 60 days (2 months).

Procurement and Preparation of Fenugreek

The fenugreek (*Trigonella foenum*-graecum L.) seeds were collected from the local market in Lahore. The seeds were cleaned with clean water, shade-dried, and ground to fine powder in a laboratory grinding machine. The powder was then prepared and stored in airtight polyethylene bags in a cool and dry place until it was administered. The amount of powder produced during the intervention period was fresh.

Study Participants

Informed consent was obtained, and a group of young females with hyperandrogenic anovulation attending the Punjab Medical Center (PMC) were recruited.

Inclusion Criteria

- Females aged 15–25 years
- Body Mass Index (BMI) > 25 kg/m²
- A condition that is known as hyperandrogenic anovulation or hormonal imbalance has been diagnosed.
- Irregular menstrual cycles
- Able to cooperate during the study

Exclusion Criteria

- Women of reproductive age who are pregnant or breastfeeding.
- Allergy to the seeds of fenugreek that can be traced back to history.
- Severe gastrointestinal disorders (e.g., Crohn's disease)
- Chronic liver disease
- Chronic kidney disease
- Herbal supplements with reproductive hormones (participants using them)

Ethical Considerations

The study received ethical clearance from the Institute's ethical approval committee of the University of Lahore prior to the study. All participants gave informed consent. The confidentiality and anonymity of the participants were ensured during the study. Participation was voluntary, and participants were free to withdraw at any stage without any consequences. There were no serious risks associated with fenugreek supplementation, and all information collected was for research purposes only.

Treatment Groups

The study was split into three groups, with each group having the same number of participants. Control Group (G0): The drug given to participants was Glucophage (Metformin) 500 mg taken daily, 30 minutes prior to breakfast, and as prescribed by their doctor. Experimental Group 1 (G1): The fenugreek seed powder (3 g, ½ tsp) was given to the participants once daily, 30 minutes before breakfast for 60 days. Experimental Group 2 (G2): The fenugreek seed powder was administered at a dose of 6 g (1 teaspoon) per day for 60 days, 30 minutes prior to breakfast.

Study Parameters

The following six parameters were evaluated pre- and post-intervention. Body Mass Index (BMI)= Standard methods were used for measuring height and weight of the participants. BMI was calculated following the formula: BMI = Weight (kg) / Height (m²). Menstrual Cycle Regularity: The menstrual cycle length, frequency, and regularity data were gathered with a structured questionnaire before and after treatment. Follicle Stimulating Hormone (FSH)= Blood was drawn overnight fasted, and serum FSH level was measured by standard laboratory methods. Luteinizing Hormone (LH)= Venous blood samples were taken to evaluate hormonal imbalance in the presence of hyperandrogenic anovulation by measuring the serum level of LH. Insulin Resistance (HbA1c) = Glycated hemoglobin (glycated Hb or HbA1c) was used to assess glycemic status and insulin resistance, with standard laboratory methods.

Lipid Profile

Fasting blood samples were analyzed to determine: Total cholesterol, High-density lipoprotein (HDL), Low-density lipoprotein (LDL), and triglycerides. Changes in these biochemical parameters after fenugreek supplementation were evaluated.

Data Collection Procedure

The hospital management gave permission before the data collection. Following informed consent, baseline information on demographic, anthropometric, medical, and biochemical investigations was taken. The participants who fulfilled the eligibility criteria were randomly divided into three study groups. They were asked to continue with their normal diet and exercise levels throughout the study. Follow-up visits were performed monthly to check adherence to treatment, document any side effects, and re-evaluate anthropometric parameters. Adherence to the intervention was also encouraged via telephone calls and a WhatsApp support group. Final evaluation was done after 60 days, and the result was compared to baseline.

Sampling Technique
The eligible participants were recruited through purposive sampling, and inclusion/exclusion criteria were predefined. The subsequent participants were then randomly divided into three groups with a simple random allocation method.

Sample Size
Sixty-nine women who met the eligibility criteria were initially recruited. The three groups had equal numbers of participants (23 for each group). In total, 60 participants completed the intervention, with 20 in each study group after an anticipated dropout rate of ~10%.

Statistical Analysis
Data collected were analyzed and entered into the statistical package for social sciences (SPSS) software version 25.0. All continuous data were expressed as mean ± SD, while all categorical data were expressed as a frequency with percentages. The differences between the three study groups were compared with the One-Way Analysis of Variance (ANOVA) and the paired comparison of baseline and post-treatment values in each group with the paired t-test. A p-value of less than 0.05 was deemed to be statistically significant.

RESULTS

Body Mass Index (BMI)
Participants' baseline BMI did not differ significantly between the three study groups. The mean pre-intervention BMI was 28.34 ± 2.69 kg/m² in the control group, 29.31 ± 2.22 kg/m² in Experimental Group 1, and 28.91 ± 1.99 kg/m² in Experimental Group 2. Following the 60-day intervention, the mean BMI decreased to 27.60 ± 2.56 kg/m², 28.53 ± 2.43 kg/m², and 26.27 ± 1.89 kg/m², respectively. There was no significant difference between groups at baseline using the Kruskal–Wallis test (H = 5.179, p = 0.075). There was, however, a statistically significant difference after treatment (H = 10.209, p = 0.006) favouring the Experimental Group 2 for the reduction in BMI.

Table 1: Effect of Intervention on Body Mass Index (BMI) among Study Groups

Group	**Pre-intervention BMI (kg/m²) Mean ± SD**	**Post-intervention BMI (kg/m²) Mean ± SD**	**Statistical Test**	**p-value**
Control Group	28.34 ± 2.69	27.60 ± 2.56	Kruskal–Wallis	0.075 (NS)
Experimental Group 1	29.31 ± 2.22	28.53 ± 2.43		
Experimental Group 2	28.91 ± 1.99	26.27 ± 1.89		
Between-group comparison			H = 10.209	**0.006***

Follicle Stimulating Hormone (FSH)
The mean baseline FSH level for the control group was 16.32 ± 1.67 mIU/mL, for Experimental Group 1, it was 16.26 ± 1.34 mIU/mL, and for Experimental Group 2, it was 16.10 ± 1.11 mIU/mL. After the intervention, the mean FSH values were 16.21 ± 1.66 mIU/mL, 15.94 ± 1.44 mIU/mL, and 15.39 ± 1.18 mIU/mL, respectively. There was no significant difference in FSH levels before treatment (H = 0.041, p = 0.980) or after treatment (H = 2.196, p = 0.333) from the Kruskal–Wallis test.

Table 2: Effect of Intervention on Follicle Stimulating Hormone (FSH)

Group	**Pre-intervention FSH (mIU/mL) Mean ± SD**	**Post-intervention FSH (mIU/mL) Mean ± SD**	**Statistical Test**	**p-value**
Control Group	16.32 ± 1.67	16.21 ± 1.66	Kruskal–Wallis	0.980 (NS)
Experimental Group 1	16.26 ± 1.34	15.94 ± 1.44		
Experimental Group 2	16.10 ± 1.11	15.39 ± 1.18		
Post-treatment comparison			H = 2.196	0.333 (NS)

Luteinizing Hormone (LH)
The control group had a mean of 14.79 ± 1.55 mIU/mL while Experimental Group 1 and Experimental Group 2 had a mean of 14.75 ± 1.80 mIU/mL and 14.53 ± 1.52 mIU/mL, respectively. Post-treatment mean LH levels decreased to 14.63 ± 1.52 mIU/mL, 13.51 ± 2.45 mIU/mL, and 13.47 ± 1.80 mIU/mL, respectively. The results of the one-way ANOVA showed that there was no significant difference between the groups before treatment (F = 0.173, p = 0.842) or after treatment (F = 2.615, p = 0.081).

Table 3: Effect of Intervention on Luteinizing Hormone (LH)

Group	Pre-intervention LH (mIU/mL) Mean ± SD	Post-intervention LH (mIU/mL) Mean ± SD	Statistical Test	p-value
Control Group	14.79 ± 1.55	14.63 ± 1.52	One-way ANOVA	0.842 (NS)
Experimental Group 1	14.75 ± 1.80	13.51 ± 2.45		
Experimental Group 2	14.53 ± 1.52	13.47 ± 1.80		
Post-treatment comparison			F = 2.615	0.081 (NS)

Hemoglobin A1c (HbA1c)

The baseline HbA1c values were 7.49 ± 1.58% in the control group, 7.44 ± 1.33% in Experimental Group 1, and 7.44 ± 1.25% in Experimental Group 2. Following intervention, HbA1c values decreased to 7.44 ± 1.58%, 7.17 ± 1.28%, and 6.52 ± 1.46%, respectively. The difference between the groups was not significant at baseline (pretreatment) using the Kruskal–Wallis test (H = 0.008, p = 0.996). However, post-treatment comparison revealed a decrease in HbA1c, which was not statistically significant (H = 5.268, p = 0.072).

Table 4: Effect of Intervention on HbA1c Levels

Group	Pre-intervention HbA1c (%) Mean ± SD	Post-intervention HbA1c (%) Mean ± SD	Statistical Test	p-value
Control Group	7.49 ± 1.58	7.44 ± 1.58	Kruskal–Wallis	0.996 (NS)
Experimental Group 1	7.44 ± 1.33	7.17 ± 1.28		
Experimental Group 2	7.44 ± 1.25	6.52 ± 1.46		
Post-treatment comparison			H = 5.268	0.072 (NS)

Lipid Profile

Total Cholesterol

The mean baseline total cholesterol levels were 233.83 ± 20.04 mg/dL in the control group, 232.35 ± 13.19 mg/dL in Experimental Group 1, and 233.43 ± 14.09 mg/dL in Experimental Group 2. Following treatment, the values decreased to 230.48 ± 20.30 mg/dL, 226.52 ± 15.01 mg/dL, and 221.09 ± 15.91 mg/dL, respectively. Before treatment, one-way ANOVA and after treatment, one-way ANOVA showed that there were no statistically significant differences (F = 0.052, p = 0.949) and (F = 1.723, p = 0.186), respectively.

Low-Density Lipoprotein (LDL)

The baseline LDL concentrations were 186.26 ± 13.50 mg/dL, 186.13 ± 18.85 mg/dL, and 188.61 ± 13.18 mg/dL for the control, Experimental Group 1, and Experimental Group 2, respectively. Post-treatment LDL values decreased to 184.13 ± 13.31 mg/dL, 182.00 ± 19.08 mg/dL, and 180.91 ± 12.42 mg/dL, respectively. There were no significant differences between the groups either before or after treatment (both p-values > 0.05) using the Kruskal–Wallis test.

High-Density Lipoprotein (HDL)

Baseline HDL values were 53.17 ± 4.69 mg/dL in the control group, 52.65 ± 4.87 mg/dL in Experimental Group 1, and 53.52 ± 5.18 mg/dL in Experimental Group 2. After treatment, HDL values were 50.30 ± 4.46 mg/dL, 45.00 ± 5.05 mg/dL, and 43.74 ± 4.87 mg/dL, respectively. No significant difference in the baseline value was found using one-way ANOVA (F = 0.182, p = 0.834), while a statistically significant difference was observed after treatment (F = 12.112, p < 0.001).

Triglycerides

The baseline triglyceride levels were 158.43 ± 6.14 mg/dL in the control group, 158.61 ± 6.20 mg/dL in Experimental Group 1, and 158.13 ± 4.63 mg/dL in Experimental Group 2. Following intervention, triglyceride levels decreased to 155.39 ± 6.87 mg/dL, 151.26 ± 7.31 mg/dL, and 143.13 ± 8.80 mg/dL, respectively. It was not found that there was a statistically significant difference (One-way ANOVA, F = 0.041, p = 0.959) before the treatment was administered. But a high-level difference was seen after treatment (F = 15.068, P < 0.001).

Table 5: Effect of Intervention on Lipid Profile

Parameter	Group	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Statistical Test	p-value
Total Cholesterol (mg/dL)	Control	233.83 ± 20.04	230.48 ± 20.30	ANOVA	0.949 (NS)

	Experimental 1	232.35 ± 13.19	226.52 ± 15.01		
	Experimental 2	233.43 ± 14.09	221.09 ± 15.91	F = 1.723	0.186 (NS)
LDL (mg/dL)	Control	186.26 ± 13.50	184.13 ± 13.31	Kruskal–Wallis	0.813 (NS)
	Experimental 1	186.13 ± 18.85	182.00 ± 19.08		
	Experimental 2	188.61 ± 13.18	180.91 ± 12.42	H = 0.463	0.793 (NS)
HDL (mg/dL)	Control	53.17 ± 4.69	50.30 ± 4.46	ANOVA	<0.001*
	Experimental 1	52.65 ± 4.87	45.00 ± 5.05		
	Experimental 2	53.52 ± 5.18	43.74 ± 4.87	F = 12.112	
Triglycerides (mg/dL)	Control	158.43 ± 6.14	155.39 ± 6.87	ANOVA	<0.001*
	Experimental 1	158.61 ± 6.20	151.26 ± 7.31		
	Experimental 2	158.13 ± 4.63	143.13 ± 8.80	F = 15.068	

Menstrual Cycle Regularity

The menstrual cycle characteristics were evaluated pre and post intervention. The age of menarche was 12.7 ± 1.3 years to 12.9 ± 1.2 years among the study groups. After treatment, 56.5% and 60.9% of the control and Experimental Group 1 groups, respectively, had regular periods, while 65.2% of the Experimental Group 2 had regular periods. The rates of amenorrhea in Experimental Group 1, Experimental Group 2, control group were 13.0%, 8.7%, and 17.4%, respectively. The average menstrual cycle length was about 29 days for all groups, and the average days of the flow were between 5.1 and 5.3.

Table 6: Effect of Intervention on Menstrual Cycle Characteristics

Parameter	**Control Group**	**Experimental Group 1**	**Experimental Group 2**
Mean age at menarche (years)	12.7 ± 1.3	12.8 ± 1.2	12.9 ± 1.2
Regular menstrual cycles after treatment (%)	56.5%	60.9%	65.2%
Amenorrhea after treatment (%)	17.4%	13.0%	8.7%
Mean cycle length (days)	~29	~29	~29
Menstrual flow duration (days)	5.1 ±	5.2 ±	5.3 ±

DISCUSSION

The purpose of the present study was to evaluate the effect of the intervention on body mass index (BMI), reproductive hormones (FSH and LH), glycemic control (HbA1c), lipid profile, and the regularity of the menstrual cycle after 60 days. Overall, the results demonstrate that the intervention resulted in beneficial effects on certain metabolic and reproductive parameters, with the highest beneficial effects being consistently seen in Experimental Group 2. Although some changes were not statistically significant, the trends observed here should be taken into account in the light of the possible effects of the intervention on metabolic health and menstruation.

The results of this study revealed that the BMI of the participants of Experimental Group 2 was significantly reduced from that of the control and Experimental Group 1. There are strong links between excess body weight and insulin resistance as well as hormonal imbalance and reproductive problems – and a modest reduction in BMI may be associated with improvements in metabolic and endocrine health (Zheng et al., 2024). In previous studies, lifestyle change and nutrition interventions have been demonstrated to facilitate weight loss and metabolic improvement, particularly in obese patients and those with endocrine diseases (Wadden et al., 2012). Experimental Group 2 results showed that increasing the intensity of the intervention or using a dual intervention was more effective. Also, biochemical and menstrual parameters showed beneficial changes that may have been associated with an improvement in BMI.

Slight decreases in the reproductive hormones were observed after treatment, but this did not significantly differ between treatment groups. These findings are also comparable to the findings of short-duration studies where it takes longer for the changes in hormones to show significant differences. There was a decrease in LH concentrations in both experimental groups when compared with the control group and greater inter-individual variability than might have limited the statistical power to detect differences (Bahougne et al., 2020). However, the downward trend implies that the intervention could be used to normalize the levels of pituitary hormones,

which is clinically relevant as high levels of LH are linked with dysfunction in reproductive processes and ovulatory dysfunction.

The intervention also resulted in a reduction of HbA1c values, most significantly seen in Experimental Group 2. While the between-group difference was not statistically significant, the clinical significance of the improvement is noted. This glycemic control loss is reflected by the HbA1C level and is generally accompanied by increased insulin sensitivity and decreased metabolic risks when it falls by this amount (Lakhani et al., 2025). This lack of statistical significance could be due to the short duration of the intervention and the small number of participants. Similarly, clinical trials conducted earlier have shown that glycemic control is more frequently improved following longer-term interventions, of >3 months' duration. The present results indicate, then, that treatment may yield even better improvements in glucose metabolism if continued (Trepanowski & Ioannidis, 2018).

The results of the lipid profile were mixed but good. The reductions in total cholesterol and LDL cholesterol were gradual in both experimental groups, but were not statistically significant. These results are similar to earlier studies which found that it took a longer amount of time for the effects of interventions on total cholesterol and LDL to be statistically significant or for a significant amount of weight to be lost (Hulten et al., 2006). But it is observed that all the experimental groups gradually decreased, indicating the beneficial effect of the treatment on lipid metabolism.

Triglyceride levels, however, had a very significant decrease following treatment, particularly in Experimental Group 2. Triglycerides are a classic parameter of metabolic dysfunction and insulin resistance, and lowering of triglycerides is a desired outcome of treatment. All of these are reported to have the same beneficial effects: dietary changes, exercise, and lifestyle changes (AbouRjaili et al., 2010). The fact that triglyceride levels were significantly lowered in this study may be interpreted to mean that insulin sensitivity has improved and more lipids are used. The results indicate that the intervention might be beneficial to cardiovascular risk factors (Yuan et al., 2022; Merdana et al., 2025).

A statistically significant difference was also observed in HDL levels following treatment. This was seen in all groups, but should be viewed with caution because HDL is considered a protective factor and an increase is considered good. This is an unexpected discovery that may be a result of a change in diet, the brief length of intervention, biological variation, or different lab measurements. There is a need to clarify the mechanism and determine if it is only temporary or has significance (Perswani et al., 2024).

Another noteworthy improvement of the present study is the improvement of the regularity of the menstrual cycle. The number of female patients with regular periods and the lowest prevalence of amenorrhea were noted in the Experimental Group 2 after treatment. Once the menstrual cycle restarts its normal pattern, it is a significant sign that the reproductive function is restored and her endocrine balance too (Maybin & Critchley, 2015; Usman et al., 2025). The results are in line with earlier studies showing that there is a strong connection between normalization of menstrual cycles and improvements in metabolic health, body weight, and insulin sensitivity. While there was no significant difference in the length of the menstrual cycle between the study groups, there was a significant increase in the number of regular cycles, which suggested improved ovulatory function, but not in the length of the cycle.

These findings can be interpreted in a variety of ways, although there are several strengths to consider. A variety of metabolic, hormonal, and reproductive endpoints were measured to gain a broad assessment of the efficacy of the treatments. In addition, homogeneity of the baseline data between the study groups made it easier to compare the groups after the intervention. However, a few limitations need to be mentioned: There's no way large hormonal and glycemic changes could have been caused by that short an intervention (Kong et al., 2016). Additionally, the small sample size used in this study might have limited the power to detect small treatment effects. Larger populations, longer follow-up periods, and evaluation of other insulin resistance and inflammation biomarkers, to gain a better understanding of the mechanisms explaining the improvements observed, should be studied in the future.

Last, a significant relationship with the intervention was found in the changes of BMI, triglyceride, HDL difference, and regularity of the menstrual cycle, particularly in Experimental Group 2. Changes in FSH and LH were not significantly different; however, there were generally favorable changes seen in most metabolic and hormonal parameters, namely, HbA1c, total cholesterol, and LDL cholesterol. These results indicate that this intervention could be a possible strategy to achieve better metabolic and reproductive performance and should be further studied in large and longer clinical trials to validate the findings.

Conclusion

In the present study, the efficacy of the intervention on changes in BMI, reproductive hormones, glycemic control, lipid profile, and regularity of the menstrual cycle was evaluated for 60 days. The findings revealed a positive impact of the intervention on most metabolic and reproductive parameters, with the greatest being in Experimental Group 2 in most cases. The results showed that there was a significant difference between the BMI of the two groups, suggesting that weight management was better in the group that received the improved intervention. Furthermore, there were benefits in the levels of triglycerides and regularity of periods, indicating better metabolic and reproductive health. In all the above parameters, there was no significant difference between the groups, whereas in the improvement parameters a positive trend was observed in all the experimental groups, with the highest value in Experimental Group 2. The findings suggest that the intervention could positively impact metabolic status and reproductive health, particularly with other interventions. Changes in body weight and

changes in lipid metabolism will further improve health outcomes by improving the general hormonal balance and improving menstrual function. Changes in body weight and lipid metabolism can also help improve general hormonal balance and menstruation, contributing to health improvements. While these positive effects were noted, the time period for the intervention and the number of participants was comparatively short, which may have reduced the ability of this study to detect significant changes in some of the biochemical and hormonal parameters. Thus, the results should be studied in larger randomized controlled trials with a longer follow-up to further validate the results and evaluate the long-term effectiveness. The general result of the study is that the intervention is safe and could be an effective way to improve some metabolic and reproductive parameters, and the best results were obtained in the Experimental Group 2. The findings will be applicable to advocating for this intervention to be used as part of an integrated intervention for metabolic and reproductive health.

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