

Comparative evaluation of different treatment regimens for managing polycystic ovarian syndrome: A long-term, prospective observational study

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Polycystic Ovarian Syndrome (PCOS) is a complex endocrino-metabolic disorder which is known to be a combination of hyperandrogenism, anovulation, and polycystic ovaries, usually along with metabolic and psychological comorbidities. Integrated AYUSH therapies provides lifestyle modification and other natural therapeutic approaches. This study was conducted on the 90 days of prospective longitudinal observation period to evaluate the efficacy of the selected AYUSH therapies - Yoga, Ayurveda, Naturopathy, and a combination of Ayurveda-Yoga-Naturopathy (AYN). Out of 183 female patients suffering from PCOS according to Rotterdam criteria, four different groups were divided; those were yoga (n=49), Ayurveda (n=50), naturopathy (n=42), and IAYN (n=42). Composite scores were used to measure the severity of symptoms at baseline and on Days 30, 60, and 90. Pearson correlation, one-way ANOVA, and descriptive statistics were used for data analysis. All four intervention groups had significant improvements during the entire study period in relation to clinical symptoms, menstrual cycle, hormonal, anthropometric profile, and Quality of Life (QoL). Naturopathy showed maximum therapeutic benefits (Mean Symptom Reduction Score=60.02±16.33), while the other three included Ayurveda (58.93±25.03), IAYN (54.99±24.67), and Yoga (48.23±18.74). Group differences in treatment outcomes were substantial (F=34.73, p<0.0001; R²=0.8967). The QoL score was greatly improved in all the groups as the respective improvement scores included naturopathy (57.32%), IAYN (51.28%), yoga (49.12%), and Ayurveda (39.13%). In conclusion, interventions like Naturopathy and Ayurveda based on CIM have proven to significantly affect symptoms and quality of life in PCOS patients. Since the participants were not randomised at random, it is impossible to determine causal effects.

Keywords: ANOVA, Ayurveda, Integrated Ayurveda-Yoga-Naturopathy therapy, Naturopathy, PCOS, Yoga

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Polycystic Ovary Syndrome (PCOS) is a complex endocrine-metabolic disease that affects a considerable number of women of reproductive age across the world, with its prevalence rate ranging from 5% to 15%, depending on the population and diagnostic criteria¹. The condition is defined by a three-fold set of symptoms: ovulatory dysfunction (expressed through oligomenorrhea and amenorrhea), hyperandrogenism (present clinically as hirsutism, acne, and alopecia), and polycystic ovarian morphology (PCOM) that can be detected with the help of transvaginal ultrasonography^{2,3}. The most frequently used diagnostic approach that implies at least two of these symptoms without other androgen excess syndromes being present is the Rotterdam criteria (2003)^{4,5}. Apart from its effects on reproductive health, the condition is also linked to a number of systemic comorbidities,

including insulin resistance, obesity, metabolic syndrome, dyslipidaemia, type 2 diabetes mellitus, and cardiovascular risks^{6,7}. Moreover, PCOS can negatively affect patients' psychological well-being and lead to depression, anxiety, and low quality of life (QoL). Crucially, PCOS is becoming more well acknowledged as a chronic illness that may last until and after menopause, highlighting the necessity of all-encompassing and long-term care strategies^{8,9}.

The pathophysiology of PCOS is complicated and multi-factorial. The neuro-endocrine abnormalities, including increased frequency of GnRH pulsatile secretion that causes high LH/FSH ratios, cause an increase in androgen secretion by the ovaries^{10,11}. High levels of insulin and insulin resistance further enhance the secretion of androgens and decrease the production of SHBG in the liver, leading to more androgens becoming available for use^{12,13}. Recent studies have shown that chronic inflammation, oxidative stress, gut

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microbiota changes, genetic and epigenetic factors also play a role in the development of PCOS^{14,15}. Conventional treatment approaches mainly focus on symptoms' relief using medications such as combination oral contraceptives, insulin sensitisers, anti-androgens and ovulation induction^{16,17}. Although useful in the short term, these interventions usually involve side effects, dependency, and inefficacy in addressing underlying etiologies such as metabolic disorders and chronic inflammation¹⁷.

As a result, research interest in multifaceted, holistic therapy approaches that might assist in addressing the complex pathophysiological mechanisms underlying PCOS is increasing. Because of its emphasis on individualised, patient-centred therapy and lifestyle modifications, AYUSH-based treatments have demonstrated potential as a successful therapeutic approach. It has been discovered that yoga treatment improves insulin resistance, lowers inflammatory levels, modifies HPA axis activity, and lessens psychological stress, all of which have a good impact on reproductive and metabolic processes^{18,19}. By evaluating the existence of dosha imbalances, the Ayurvedic treatment system considers a personalised treatment plan that includes a variety of therapeutic techniques, including nutrition, medicines, Panchakarma, and lifestyle modifications. Similar to this, naturopathy emphasises the body's innate capacity for healing through therapeutic diets, detoxification, hydrotherapy, exercise, stress reduction, and behavioural modifications aimed at improving metabolic health and overall well-being^{20,21}.

Due to the accumulation of many scientific research studies which have validated these techniques, there is a growing interest in Complementary and Integrative Medicine (CIM), where evidence-based complementary medicine is used together with mainstream medicine for better health outcomes. However, this research study does not look into the application of integrative medicine from the aspect of conventional CIM. Instead, this research tries to understand the structure of an integrated AYUSH-based medical approach to treatment which involves the integration of Ayurveda, Yoga and Naturopathy in a systematic manner using AYUSH medicine. The approach was designed to overcome the disturbances created in the endocrine system, metabolism, inflammation, psychological as well as life style aspects causing the occurrence of PCOS. The purpose of the intervention is to provide holistic and

complementary treatments of various aspects of the disease instead of only dealing with its symptoms.

Though many researchers have shown interest in exploring alternative therapies for PCOS, there seems to be quite a bit of scattered literature in this regard. Majority of the literature in this context has considered only one of the systems stated above like Yoga, Ayurveda or Naturopathy as an individual therapy, used shorter duration of therapy or had poor study design. Apart from that, majority of the earlier studies have concentrated on individual variables like hormones, insulin resistance, anthropometric measurements, menstrual function, metabolic parameters and psychology but did not consider the complete spectrum of symptoms associated with PCOS.

To overcome these gaps in knowledge, the ongoing prospective longitudinal observational study attempts to compare the efficacy of Yoga, Ayurveda, Naturopathy and a combination of all three in a 90-day study period with the help of standardized and validated outcome measures. Symptoms and quality of life differences have been noted during certain follow-up periods so that an assessment of the interventions can be effectively made. These outcomes of the study are anticipated to generate scientifically valid information on the efficacy of these interventions not only separately but also collectively by taking into consideration several clinical, hormonal, metabolic, and patient reported measures. The findings of this study will contribute to the existing knowledge base in the field of management of PCOS through the integration of AYUSH systems, which would eventually pave the way towards evidence-based management strategies for PCOS patients.

Methodology

Study design and setting

This 90-day prospective longitudinal observational study compared the therapeutic efficacy of Yoga, Ayurveda, Naturopathy, and Integrated Ayurveda-Yoga-Naturopathy therapy in managing PCOS symptoms. Conducted from October 2023 to October 2024, it took place across three departments in Haridwar, Uttarakhand: The Department of Yog & Shatkarma (Patanjali Yogpeeth), the Department of Streeroga and Prasuti Tantra (Patanjali Bhartiya Ayurvigyan Evam Anusandhan Sansthan), and the Patanjali Wellness Centre. Each Centre follows standardized clinical protocols and offers specialized

CIM-based treatments. The coordinated of Ayurvedic, yoga, and naturopathic therapies provided within an AYUSH healthcare framework is referred to as integrated therapy for the purposes of this study. It is not an example of integrative medicine that uses traditional biological therapies. In accordance with institutional clinical guidelines, participants in this group received standardised therapies from all three AYUSH disciplines.

Ethical approval and considerations

The study protocol was approved by the Institutional Ethics Committee of Patanjali Research Foundation (IEC No: PAC/IEC/2023/6/15) in accordance with the Declaration of Helsinki²². Participants provided informed consent after being fully briefed on the study's nature, procedures, and their rights. No financial incentives were given. Data confidentiality was maintained, and only standard, evidence-based CIM interventions were used, with no investigational drugs or invasive procedures involved.

Participant selection criteria

Participants were enrolled based on predefined inclusion and exclusion criteria to ensure the reliability and relevance of the study outcomes.

Inclusion criteria	Exclusion criteria
Females aged 18-45 years	Due to potential menopausal hormonal changes
Confirmed PCOS diagnosis as per ICD-10-CM Code E28.2 ²³	Presence of non-PCOS-related pathological, hematological, or hormonal disorders
Symptom duration of ≥ 6 months	Pre-existing thyroid dysfunction
Minimum 3 months of prior participation in one of the four non-pharmacological treatment modules	Psychiatric disorders, hypertension, or pregnancy/lactation
Presence of at least one PCOS clinical manifestation:	History of unrelated gynaecological disorders
Polycystic ovaries (confirmed by ultrasonography)	Hormonal contraceptive use within the past 3 months
Virilization, infertility, pelvic pain	Unwillingness to participate or provide informed consent

Hirsutism, androgenic alopecia, acne, oily skin, dandruff, or acanthosis nigricans	Participants with inadequate baseline or follow-up data were eliminated from the final analysis
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Sample size and group allocation

The required sample size for this study was calculated based on the estimated prevalence of PCOS among Indian women of reproductive age, which stands at approximately 22.5%^{24,25}. To ensure statistical rigor for detecting differences in outcomes across multiple intervention groups, the sample size was determined using the following formula for comparing group means *via* one-way ANOVA:

$$\eta = \frac{2(Z_{1-\alpha/2} + Z_{1-\beta})^2 \cdot \sigma^2}{\Delta^2}$$

where: η = required sample size per group, $Z_{1-\alpha/2}$ = Z value for 95% confidence (typically 1.96), $Z_{1-\beta}$ = Z value for 80% power (typically 0.84), σ = pooled standard deviation (estimated from pilot data), Δ = minimum detectable difference in outcome (e.g., change in QoL score)

In present study, the pooled standard deviation (σ) was determined using variations found in the preliminary pilot data and confirmed by earlier studies that used the similar composite measure of symptoms and QoL in PCOS population. The minimal detectable difference (Δ) is defined as the smallest difference in the changes in the measured outcome (e.g., decrease in symptoms or improvements in QoL) between the intervention groups. This set of criteria was selected to maintain statistical power and ensure adequate sensitivity of the study. Conventional approaches in determining the sample sizes for comparison of the mean values between different groups *via* one-way ANOVA, as described in reliable statistical methodological sources, were used in the current study. With consideration of possible attrition rate and individual variations in the participants, the targeted number of participants was set to 200, with at least 42 in each group after attrition. The adequate statistical power ($\geq 80\%$) to identify significant intergroup differences was ensured by these cautious alterations. The acquired sample size maintained the intended power threshold in spite of participant attrition, according to post hoc power analysis.

Group allocation

A total of 183 subjects who were eligible according to the inclusion criteria were included in the study.

Subjects were assigned to one of the four intervention groups namely: Ayurveda (n=50), yoga (n=49), naturopathy (n=42), and Integrated Ayurveda-Yoga-Naturopathy therapy (n=42). Allocation to intervention groups involved a non-randomized allocation technique based on preferences, consistent with the pragmatic approach to CIM. Subjects were permitted to select the preferred modality for treatment in consultation with the CIM practitioner, with an objective of ensuring adherence and ecological validity. After 90 days of intervention, the number of subjects in the groups was as follows: Ayurveda (n=41), yoga (n=46), naturopathy (n=37), and Integrated Ayurveda-Yoga-Naturopathy therapy (n=35). The allocation method used is realistic for pragmatic clinical settings, but with some bias in patient selection. However, there were sufficient numbers of participants in each group to make meaningful comparisons between the groups statistically.

Interventions

Over the 90-day period of observation, the subjects in each group were exposed to systematic, system-specific non-drug treatments in accordance with the philosophy of Ayurveda, yoga therapy, or naturopathy. Every treatment protocol was designed with the view to addressing all the aspects of the pathophysiology of PCOS, which include neuroendocrine imbalance, insulin resistance, systemic inflammation, and psychological stress. The treatment protocols were standardized and given under the watchful eyes of experts. The treatment protocols selected for the present study have been selected based on the following three major criteria:

- Classic texts on Artava Dushti, Kapha-Medovridhi, and Agnimandya in Ayurveda
- Clinical study research on the efficacy of Yoga, Ayurveda, and Naturopathy in PCOS.
- Standard protocols followed by the Patanjali Wellness Centre and AYUSH Hospitals

These have been selected for their proven efficacy in improving menstrual regulation, insulin resistance, obesity, stress, hormonal imbalance, and QoL.

Ayurveda

The Ayurveda subjects were provided with personalized therapeutic regimens as per their Ayurvedic diagnoses. The main treatment regime involved the use of various herbal preparations including *Kanchanara Guggulu*, which has the capacity to detoxify the lymphatic system and balance hormones; *Triphala*, which is effective in improving

the digestive health of patients; and two adaptogens, *Shatavari* (*Asparagus racemosus*) and *Ashwagandha* (*Withania somnifera*), that regulate the hypothalamic-pituitary-ovarian (HPO) axis. The selected participants were also subjected to Panchakarma therapy for detoxification, where the procedures include *Virechana* (purgative treatment), which removes the excessive accumulation of *Pitta* and *Kaphadoshas* from the body and improves liver function, and *Matra Basti* (oil enema), which helps to balance *Vatadosha* and nourishes reproductive tissues. Further, the participants were advised about *Pathya-Apathya* (diet), *Ritucharya* (lifestyle based on seasons), and proper sleeping habits through Ayurveda counselling.

Yoga

The yoga group adhered to a strict therapeutic yoga regimen that included six days a week of 60-min supervised sessions led by professional yoga therapists with knowledge of women's health. Targeted asanas (postures) that stimulate ovarian and endocrine function, such as *Baddha Konasana*, *Bhujangasana*, *Dhanurasana*, and *Setu Bandhasana*, were used in the intervention. These poses improve adrenal health, increase pelvic blood flow, and improve hormonal balance. In order to promote autonomic balance, lessen sympathetic overactivation, and lessen hormonal disturbances brought on by stress, breath control methods (pranayama) including *Nadi Shodhana*, *Anulom Vilom*, and *Bhramari* were incorporated. Additionally, mindfulness-based techniques like meditation and guided imagery were incorporated into the sessions with the goal of lowering cortisol levels, promoting emotional wellbeing, and reducing psychological stress.

Naturopathy

The naturopathic group was administered a comprehensive and lifestyle-oriented treatment program designed for natural and non-invasive interventions that can help stimulate the body's own natural ability to heal itself. An important aspect of the therapy program was a therapeutic diet consisting of high-fibre, low glycemic index foods with an emphasis on whole and unprocessed foods, lean proteins, and good fats. The other forms of therapy provided were hydrotherapy techniques involving alternating sitz baths of hot and cold water for increased circulation of the pelvis, cold packs applied to the abdomen to facilitate digestion and functioning

of reproductive organs, and spinal sprays to balance autonomic nervous system tone (Fig. 1). In addition, patients were informed about safe and controlled exposure to sunlight for the production of vitamin D, which is generally low in PCOS cases, and to ensure proper functioning of circadian rhythms.

Participants also received counselling on stress management, hydration, physical activity, and sleep hygiene. The Integrated Ayurveda-Yoga-Naturopathy therapy participants were subjected to a planned combination of treatments including Ayurveda, Yoga, and Naturopathy following a pre-planned treatment protocol. Ayurveda herbal medicines and Panchakarma therapies were planned in such a manner that they went hand-in-hand with the daily practice of yoga including asana therapy, pranayama, and meditation. Naturopathy therapies, including diet counselling, hydrotherapy, and lifestyle changes were used to support the Ayurveda and Yoga therapies. In order to ensure compatibility between various therapies and an individualised approach to therapy, this treatment plan was designed in conjunction with Ayurvedic physicians, yoga instructors, and naturopathic therapists.

Outcome measures and assessment tools

The systematic approach for assessing the effects and effectiveness of all the four non-pharmacological interventions was adopted for this study through the use of a structured and multi-dimensional evaluation procedure for the entire 90-day period. The assessment protocol comprised three important steps that aimed at gathering both objective measures of changes and subjective responses. In the first step, demographic data including age, place of residence, education, and religion were collected. This step was supposed to allow identifying potential socio-demographic factors that could influence the effectiveness of the treatments. The second step aimed at evaluating risk factors related to general health conditions that are usually associated with PCOS through a 20-question checklist scored on a 4-point Likert scale where 1 denoted the best health status and 4 the worst one²⁶. The objective of this section was to obtain a baseline assessment of risks associated with metabolism, inflammation, and lifestyle factors, which might affect therapeutic results in all groups receiving intervention. The third and main part utilized the well-established Self-

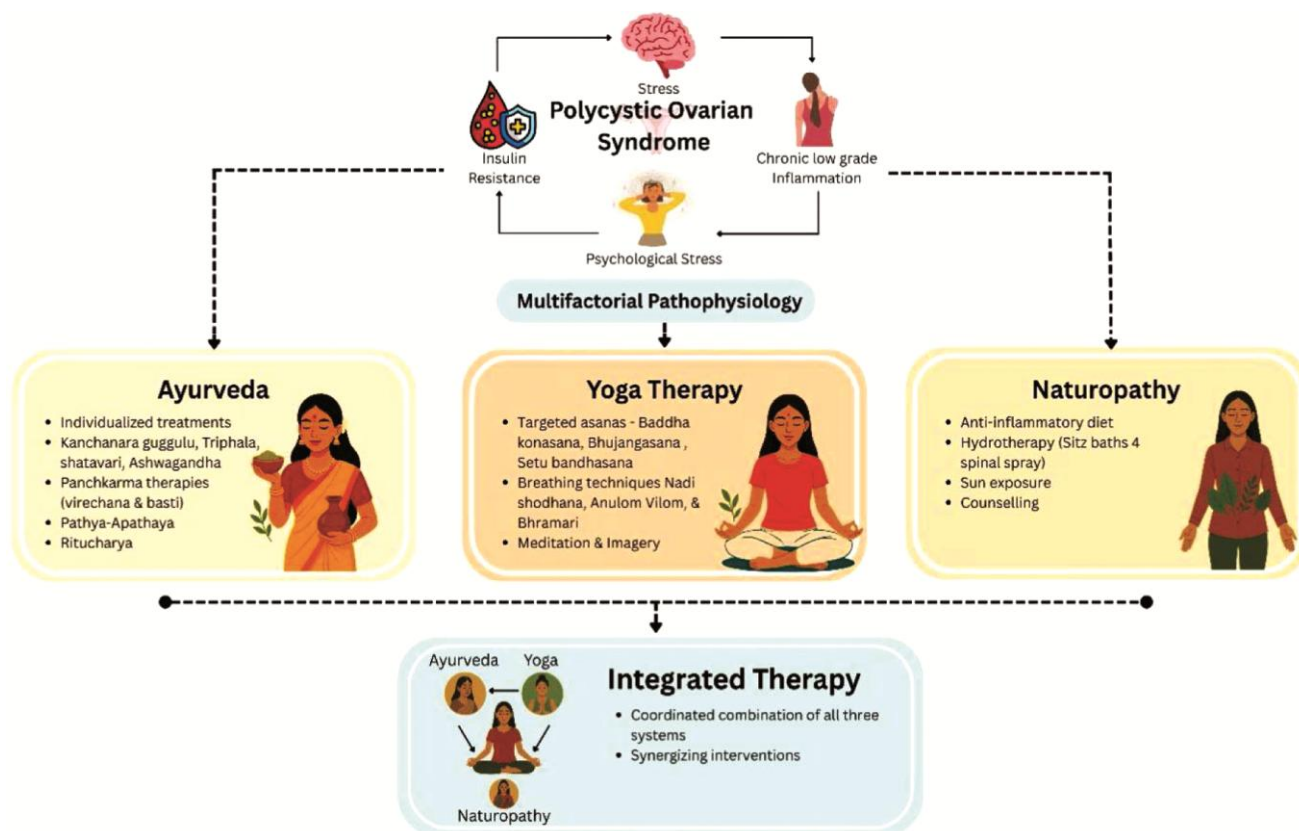


Fig. 1 — Study-based integrative interventions for effective PCOS management in participants

Administered Polycystic Ovary Syndrome Questionnaire (PCOSQ) to measure health-related quality of life (HRQoL) in five dimensions: emotional state (8 questions), hirsutism/ body hair growth (5 questions), weight concerns (5 questions), infertility worries (4 questions), and menstrual irregularity (4 questions).²⁷ All the 26 questions were answered on a 7-point Likert scale where higher scores implied better health perception and functioning. The PCOSQ is characterized by good internal consistency ($\alpha > 0.7$) and validity, making it a proper instrument for holistic interventions assessment.²⁸ This multivariable tool was applied uniformly in all the different treatment groups to ensure the comparison of results. In the Ayurveda treatment group, the main results were measured on the basis of changes in the menstrual pattern, hormonal balance and systemic cleansing. In the yoga treatment group, the focus was on the psychosomatic outcomes like emotional stability, cortisol regulation and autonomic regulation. In the naturopathy treatment group, the results measured were those of metabolic normalizing, adherence to diet and alleviation of symptoms associated with inflammation. In Integrated Ayurveda-Yoga-Naturopathy treatment group, composite outcomes from different spheres were assessed to measure synergic effects of various therapies. This systematic and standardized process of outcome evaluation facilitated intergroup and intragroup evaluations and was consistent with the comparative nature of the study and helped in evaluating the evidence-based integrative approaches for PCOS.

Statistical analysis

Data collection and statistical analyses were conducted by the aid of the following software tools: Microsoft Excel 365 to organize data initially, GraphPad Prism to visualize the data, and IBM SPSS Statistics version 26 for conducting more complex statistical analysis. All data collected on all groups of subjects both before and after the intervention were analyzed according to a specific methodology that was designed to analyze the dynamics of the process and differences between groups regarding their effectiveness. Descriptive statistics were calculated in order to characterize the distribution of outcomes variables such as mean, standard deviation, range, skewness, and kurtosis across all time points (Day 0, Day 30, Day 60, and Day 90). Pearson correlation matrices were used to study relationships between outcome variables and consistency of subject

responses throughout the intervention and different treatment techniques²⁹. One-way Analysis of Variance (ANOVA) was performed in order to find statistically significant differences between the results for the four groups³⁰. This multilevel statistical method helped ensure the reliability and validity of the obtained data with respect to the effectiveness of each of the interventions on PCOS symptoms and QoL³¹.

Results

The study population ($n = 183$) comprised women ranging in age from 18 to 45 years, suffering from PCOS. Baseline demographics and clinical characteristics of the participants, including age range, duration of symptoms, and clinical presentation, were comparable between all four treatment groups, thus making them suitable for comparison between groups. A 90-day longitudinal observational study was conducted to assess the relative effectiveness of four CIM treatment approaches for the management of PCOS and its diverse symptoms. A multidimensional assessment was performed on the basis of the PCOSQ symptom score composite. Statistical methods used in the study included Pearson correlation matrices, descriptive statistics, and one-way ANOVA.

Comparative efficacy: Mean symptom scores across treatment arms

The higher scores indicate more severe symptoms and the Y-axis shows the composite assessment score, which is obtained from a comprehensive evaluation of PCOS-related symptomatology (Fig. 2). Treatment modalities are shown on the X-axis, where grouped

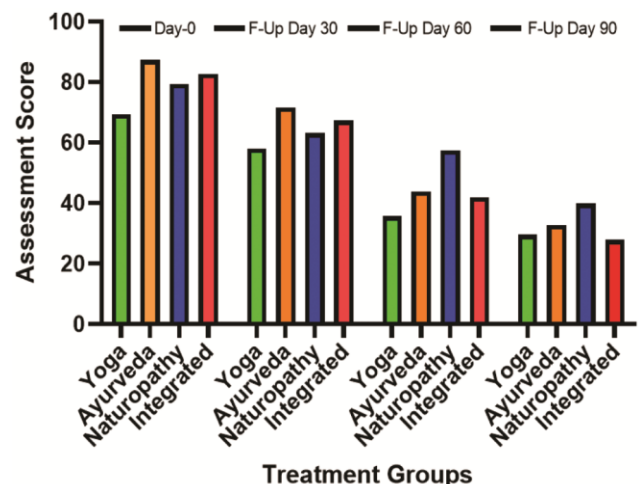


Fig. 2 — Comparative evaluation of several treatment groups and their analysis scores

bars represent symptom ratings at baseline (Day 0) and follow-up intervals on Days 30, 60, and 90, respectively. All treatment groups have higher scores at baseline (Day 0), which is indicative of a moderate-to-severe clinical load at the start of the trial. Over the course of the intervention, all four modalities show a gradual and significant drop in evaluation scores, indicating a clinically significant improvement in symptoms. By Day 90, naturopathy and Ayurveda showed the most pronounced decreases across the groups, indicating greater effectiveness in reducing PCOS's metabolic, endocrine, and reproductive symptoms. The integration of Ayurveda-Yoga-Naturopathy, which displayed strong intermediate reactions on Day 30 and Day 60, appears to have a relatively weakened progression at Day 90, which can be linked to the difficulty of adherence to several approaches or perhaps even the overlap of mechanisms. In contrast, the Yoga group, while useful, demonstrates relatively weak progress during all time intervals, indicating that the approach is mainly focused on neuroendocrine and stress management rather than systemic metabolic changes. As a result, Figure 3 illustrates the temporal

effectiveness gradient among CIM modalities and visually supports the statistically significant intergroup differences reported in the study.

Inter-modality correlations and longitudinal response dynamics

A Pearson correlation matrix was generated at each time point (Day 0, Day 30, Day 60, and Day 90) in order to explore how treatment efficacy evolved and the extent to which intervention outcomes were correlated (Supplementary Table S1). The yoga and Ayurveda groups showed a significant association ($r=0.979$) at baseline (Day 0), indicating similar participant profiles in terms of initial symptom intensity and potentially overlapping demographic or psychosomatic attributes. The intergroup correlation patterns did, however, significantly change as the intervention carried on. The naturopathy and Integrated Ayurveda-Yoga-Naturopathy therapy groups showed the highest association by Day 90 ($r=0.912$), suggesting a gradual convergence in clinical response. This changing association pattern suggests that naturopathy and Integrated Ayurveda-Yoga-Naturopathy therapy may interact with comparable physiological targets, especially those

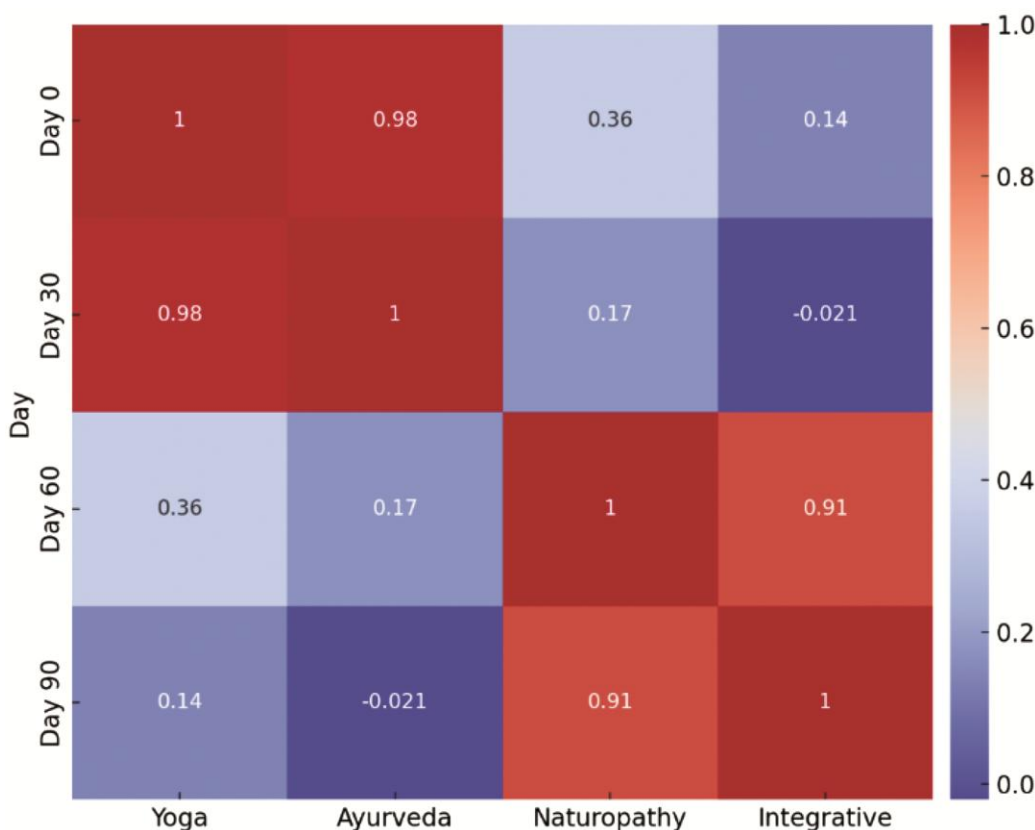


Fig. 3 — Pearson correlation coefficient heat map visualisation showing the correlations between treatment responses over time

controlling metabolic balance, endocrine regulation, and systemic detoxification, although having different therapeutic frameworks. The convergence of results in these two groups probably reflects a common focus on anti-inflammatory tactics, hepatic function optimisation, and glycaemic modulation all of which are essential to the pathophysiology of PCOS. Conversely, the early affinities between yoga and Ayurveda could be explained by their similar impact on neuroendocrine parameters including stress reduction and the balance of the hypothalamic-pituitary-adrenal (HPA) axis. These results demonstrate how treatment response is dynamic and time-sensitive, emphasising the significance of both the initial patient phenotype and the underlying mechanistic focus of each modality in determining long-term therapeutic trajectories³². However, these correlations should be interpreted cautiously and primarily as exploratory patterns rather than definitive statistical linkages because treatment groups represent separate categories.

The heatmap represents the results of Pearson correlation coefficients obtained to evaluate the level of similarity in clinical response profiles among four modes of treatment administered over four time periods (Day 0, Day 30, Day 60, and Day 90) over 90 days for the management of PCOS (Fig. 3). The color range spans from deep red ($r=1.0$, signifying perfect positive correlation) to dark blue ($r=0$, signifying no correlation), thereby providing an easy-to-understand depiction of the changing inter-modal correlations over time. At Day 0 (baseline), there was a very high positive correlation between the yoga group and the Ayurveda group ($r=0.98$), which implies that there was considerable similarity in the profiles of the participants or the levels of their symptoms at baseline within these two groups. The correlation remained very high ($r=0.98$) even at Day 30, probably because of similar effects on neuroendocrine regulation and stress modulation. However, the correlations among these two groups compared to those of the naturopathy/integrative groups were much lower at the early stages (e.g., Yoga & naturopathy, $r=0.36$ on Day 0; Yoga & Integrative, $r=0.14$ on Day 0) because of different approaches towards their actions and target physiology. As the intervention progressed on, a significant change in correlation structure became apparent. By Day 60, there was significant association ($r=0.91$) between the naturopathy and Integrated Ayurveda-Yoga-

Naturopathy therapy groups. This correlation persisted until Day 90 ($r=0.91$). Despite having different designs, this temporal rise in convergence implies that these two modalities may act on comparable underlying metabolic and endocrine regulatory mechanisms, especially through hepatic detoxification, glycaemic control, and inflammatory regulation. However, the relationship between yoga and other modalities became progressively weaker, achieving a minimum level on Day 30 in relation to Integrated Ayurveda-Yoga-Naturopathy ($r=-0.021$), and on Day 90 in relation to Ayurveda ($r=-0.021$), emphasizing the contrasting course of therapy and the distinctive, perhaps supplementary, nature of yoga. This heatmap gives information about the changing correlations among different CIM techniques used for PCOS treatment from both quantitative and temporal standpoints. The early correlation between yoga and Ayurveda is likely due to stress-related effects; the later correlation between naturopathy and Integrated Ayurveda-Yoga-Naturopathy is indicative of metabolic alignment. These results highlight how crucial it is to match treatment approaches to the pathophysiology and temporal dynamics of diseases in order to maximise clinical results.

Temporal descriptive statistics of symptom progression

The temporal study of symptom scores using the four important stages of Day 0, Day 30, Day 60, and Day 90 showed a consistent and systematic decline in the mean scores, showing that there is an improvement in the clinical symptoms of the condition throughout the 90 days of treatment. In order to describe the distribution of treatment responses, various descriptive statistical measures have been considered, which include the calculation of mean, standard deviation (SD), range, skewness, and kurtosis. The above-mentioned measures give an idea about the central tendency, dispersion, and the shape of the distribution of data. The temporal description of these parameters (Supplementary Table S2).

Consistent decrease in mean values indicates systematic improvement in symptoms. Negative to positive skewness change and maximum kurtosis at Day 60 (2.029) is an indicator of cluster formation of low symptom values for a group of high responders, especially among the naturopathy and Integrative intervention groups. There was a consistent and statistically significant decrease in mean values from baseline (79.75) to Day 90 (32.55) which indicated consistent clinical improvement for all interventions.

The change in skewness value from negative to positive means that although the subjects entered the study with a cluster of high symptom values, at Day 90 many more of them had low symptom values. Increase in kurtosis value at Day 60 (2.029) shows an increased consistency in responses, especially in the naturopathy and Integrative interventions.

One-Way ANOVA: Intergroup variability in treatment response

Statistical inference through ANOVA test was used to determine if the differences in the effectiveness of treatments between the four intervention groups were statistically significant. The ANOVA technique was used to measure the level of differences in symptom improvements of participants belonging to each group after the interventions. The results obtained from the ANOVA test revealed significant difference in the effectiveness of the different treatments, indicating that there was some effect of the type of intervention on the outcomes (Supplementary Table S3).

A significant difference between the treatment groups is shown by the F-value of 34.73, and the statistical significance of these differences is confirmed by the p-value (<0.0001). Further supporting the model's robustness is the R-square value of 0.8967, which indicates that variations in treatment approaches account for 89.67% of the variability in treatment effectiveness. The between-group variance (Sum of Squares=5291, Mean Square=1764) is significantly greater than the within-group variance (Sum of Squares=609.3, Mean Square=50.78), according to the ANOVA statistical breakdown. This suggests that the differences across the various therapy approaches are substantially larger than the differences within each group. Specific pair wise differences across treatment modalities could not be identified since post-hoc comparisons were not carried out, despite the fact that one-way ANOVA indicated significant differences among groups^{33,34}. These results imply the therapeutic effect for managing PCOS varies among treatment modalities. The potential for tailored and integrated treatment approaches to improve patient outcomes as shown by the observed statistical significance.

Discussion

This study shows the varying effectiveness of four non-pharmacological, CIM-based PCOS treatment strategies over a 90-day period. Considerable heterogeneity in results supports tailored treatment plans

and emphasises the significance of processes unique to a certain modality. The highest clinical effect (60.02 ± 16.33) was observed by naturopathy, which is correlated with studies correlates PCOS to inflammation, insulin resistance, and dysregulated lifestyle. Its regimen, which included a low-glycemic diet, anti-inflammatory nutrition, hydrotherapy cleansing, sun exposure, and behavioural change, probably enhanced hepatic function, insulin sensitivity, and hormonal balance, returning the HPO axis to normal. Additionally, the patient-centered design may have improved adherence. Based on prakriti-vikriti evaluations and the traditional concepts of Shodhana, Rasayana, and Satvavajaya, Ayurveda came in second (58.93 ± 25.03). Menstrual and hyperandrogenic symptoms were probably alleviated by polyherbal formulations (Kanchanara Guggulu, Shatavari, Ashwagandha) and Panchakarma (Virechana, Matra Basti) that enhanced gut-liver function, promoted endocrine normalisation, and cleared toxins. Surprisingly, compared to solo naturopathy and Ayurveda, Integrated Ayurveda-Yoga-Naturopathy therapy produced less improvement (54.99 ± 24.67), might be because of protocol complexity, therapeutic overlap, or less compliance. The effectiveness of the integrated model was slightly lower than the effectiveness of individual naturopathy, yet there was some clinical improvement. As opposed to being ineffective, this could be attributed to common therapeutic actions, patient compliance, or the increased complexity of combined therapies. However, the close connection between naturopathy and the integrated approach ($r=0.91$) implies similar therapeutic actions within both metabolic and endocrine restoration processes, showing some promise for the future. Yoga was the least effective modality (48.23 ± 18.74), yet it contributed to improving psychological state and autonomic stability. Yoga postures, breath-work and meditation could help in reducing cortisol levels and activating parasympathetic nervous system, yet limited results in relation to endocrine parameters point out the necessity of yoga application as an auxiliary therapy^{35,36}. The findings of this study demonstrate a time-based relationship between the intervention and the outcome, not necessarily causation, as well as affected by the fact that the non-random assignment was done on preference basis, which might create bias as a consequence. An absence of a control group represents a weakness of this study because it restricts the possibility to attribute the improvement in patients' symptoms to the treatment

alone. Confounding is also more likely to happen in the light of the fact that the non-randomized design was used. When assessing the findings, such variables as patient compliance with the treatment, diet, and lifestyle should be considered. Conclusively, the effectiveness of naturopathy and Ayurveda was more significant, yoga provided additional benefits, and there is need for better structure of the IAYN treatment. Although the outcomes of this research support previous studies in terms of lifestyle and alternative medicine approaches, further research is still needed to confirm their validity.

Conclusion

In conclusion, this prospective longitudinal observational study with non-randomized group allocation demonstrates significant associations between combined AYUSH treatment and improvement of symptoms associated with PCOS and QoL. The most significant reduction in the level of symptoms severity was shown for naturopathy and Ayurveda treatments as compared to other types of treatment. Nevertheless, when considering this data, it should be taken into account that there is no control group in this study and the influence of possible confounders should also be considered. Therefore, the findings need to be considered in relation to associations and not as concrete evidence for efficacy. Conducting further randomized controlled trials using objective biochemical and imaging markers, extended duration, and a defined protocol for integration is necessary to determine causality and validate the effectiveness of complementary AYUSH therapies over the long term in the management of PCOS. Rather than integrative medicine combining conventional medicine, the integrated intervention used in this research involves a combination of Ayurveda, yoga, and naturopathy.

Supplementary Data

Supplementary data associated with this article is available in the electronic form at [https://nopr.niscpr.res.in/jinfo/ijtk/IJTK_25\(8\)\(2026\)792-803_SupplData.pdf](https://nopr.niscpr.res.in/jinfo/ijtk/IJTK_25(8)(2026)792-803_SupplData.pdf)

Constraints of the study

The non-randomized and preference-based design of the study carries with it the potential bias of the selection process, thus weakening any inferences made from it. Absence of multiple comparisons after the post-hoc process decreases the potential of

establishing statistically significant differences between the groups. Dependence solely on subjective measures of effectiveness without the use of biochemical and imaging markers lowers the scientific validity of the results. The group that received Integrated Ayurveda-Yoga-Naturopathy treatment proved to be less effective because of the lack of proper sequencing of treatment or the difficulty in the combined treatment. Moreover, the 90-day period may be too short to evaluate long-term effects on a chronic disorder such as PCOS. However, Yoga proved to be effective in improving the metabolic profile, but only as an adjunct treatment measure.

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Author Contributions

The authors confirm their contribution to the paper: SS: collected data and drafted the manuscript; VA: designed interventions and reviewed content; RKM: Supervised data analysis and revisions; SKR: led the study design and finalized the manuscript. All authors reviewed the results and approved the final version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

Ethics Statement

The study protocol was reviewed and approved by the Institutional Ethics Committee of Patanjali Research Foundation (IEC No: PAC/IEC/2023/6/15) in accordance with the principles of the Declaration of Helsinki.

Informed Consent

The written informed consent was obtained from all participants before their inclusion in the study. Participants were informed about the study objectives,

procedures, and their right to withdraw at any time without any consequences.

Consent for Publication

Not applicable.

Use of Artificial Intelligence (AI)

The authors state that no AI technologies were utilised for statistical analysis, data production, figures, result interpretation, or scientific decision-making. The sole purpose of AI-assisted language editing tools was to enhance readability and grammar. The manuscript is entirely the authors' responsibility.

Data Availability

The datasets created and/or processed during the current investigation are accessible from the corresponding author upon reasonable request.

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