

Introduction

The future reproductive life of a woman will be affected by the significant physical, emotional and social changes that occur in her reproductive stage. In women's overall wellbeing, reproductive health is a fundamental aspect, particularly for young adult women. According to WHO (2021), Reproductive health is more than just not being sick or having a disease. It means being completely healthy in all areas of life, including the reproductive system, its functions, and its processes. This includes things like menstruation, sexually transmitted infections, and chronic conditions like polycystic ovarian syndrome. Ability of young adult women to make wise choices by recognising the significance of the reproductive stage is a very crucial for improving their quality of life and helping them to fully engage in societal activities.

Polycystic Ovarian Syndrome, which is also known as hyperandrogenic anovulation or Stein-Leventhal syndrome, is one of the most common endocrine complaints affecting women of reproductive age. Menstrual dysfunction, infertility, hirsutism, obesity and acne are characteristic features of this chronic and heterogeneous illness. To be diagnosed with polycystic ovarian syndrome (PCOS), a person must have at least ten tiny cysts that are between two and nine millimetres in diameter and at least one ovary that is bigger than ten milliliters (Singh et al., 2023). PCOS and PCOD are two different conditions, are not the same conditions. PCOD is a reproductive condition which develops because of poor lifestyle, stress and hormonal imbalance. In this condition, ovaries contain immature follicles. Most cases are identified when the person is in their late teens or early 20s, which is a time when the quality of the eggs is usually not very bad. PCOS has more long term risks as compared to PCOS.

Motlagh and colleagues (2022) estimated that 9.2 per cent of reproductive-age women globally have PCOS, a metabolic disorder and also revealed that most of the women go undetected, which emphasizes the need for further awareness campaigns and medical system action help to reduce this major reproductive health issue. By Rotterdam

criteria (2003), 13.6 per cent of Polycystic Ovarian Syndrome was found among young adult students from the Navodaya Group of Institutes of 500 volunteers, 68 experienced hirsutism and oligomenorrhea (Pallavi, 2024).

Using the Rotterdam Criteria and the International Evidence-based Guidelines, Neven and colleagues (2024) investigated the worldwide prevalence of PCOS among teenagers across nations and discovered that 9.8 per cent were PCOS using the Rotterdam Criteria and 6.3 per cent were PCOS using the International Evidence-based Guidelines. Targeted healthcare interventions are required since areas with moderate to high socio-demographic indices have the greatest incidence rates (Liu *et al.*, 2024).

Tamil Nadu teenage girls' pilot cross-sectional study found 18 per cent PCOS frequency (Balaji *et al.*, 2015). Among medical students at a private Medical University in South India who answered the 10-item modified Cronin Questionnaire, PCOS was common and also suffered rather high rates of mood problems (Ganie *et al.*, 2019). According to Vidya Bharathi *et al.* (2017), Rotterdam Criteria-diagnosed PCOS affected 16 per cent of rural and urban Chennai's community-dwelling women. JAMA Network Open published in 2024 a national prevalence of Polycystic Ovarian Syndrome in Indian women of 7.2 per cent employing NIH criteria and 19.6 per cent utilizing Rotterdam Criteria. Most often occurring (40.8 per cent) was PCOS phenotype C.

The pathophysiology of PCOS is multifactorial, involving hormonal imbalances and metabolic dysfunctions. Key physiological changes include increased luteinizing hormone (LH) levels, decreased follicle-stimulating hormone (FSH), and elevated androgen levels, which disrupt normal ovarian function and lead to follicular arrest and anovulation (Upadhyya *et al.*, 2018). The findings of Martin's study (2024) showed that dysfunction of the adipocyte contributes to the pro-inflammatory cytokine production, which impairs insulin signalling that underscoring the notable relationship between PCOS and obesity pathology. For developing targeted interventions and management strategies for PCOS women, understanding these physiological mechanisms is very important

PCOS is not technically essential for diagnosis, though it is characterised by the uncontrolled release of LH and FSH, hormones that control ovarian steroidogenesis, follicular dynamics, and ovulation. This means that the main symptoms of PCOS, like

hyperandrogenism and irregularity in ovulation, might be affected by the way gonadotropins are released. Key indicators of PCOS include elevated LH levels, increased LH:FSH ratios, alterations in LH pulse frequency and/or amplitude, and relatively low FSH levels. (Azziz *et al.*, 2016). Over the past ten years, kiss1 neurons—which generate kisspeptins (coded by the *KISS1* gene)—have become master controllers of GnRH neurosecretion and ovulation.

For women in their reproductive years, PCOS produces most ovarian malfunction at 8–13 per cent. Clinically and biochemically hyperandrogenism, polycystic shape, and oligo/anovulatory ovarian dysfunction define PCOS. PCOS often stops small antral follicular development, therefore preventing ovulation. PCOS is induced by low-grade inflammation, hyperandrogenism, insulin resistance, and LH>FSH. Of couples, about 25 per cent experience problems with ovulation (Orisaka *et al.*, 2023).

WHO (2023) claims PCOS causes ovarian cysts, increased androgen, hormonal abnormalities, and irregular periods. Unequal intervals without ovulation can complicate a pregnancy. PCOS is the main reason for infertility. This chronic illness cannot be cured with anything. Some symptoms can be addressed with changes in lifestyle, drugs, and fertility treatments.

Because of ovulatory disturbance, PCOS often results in infertility. Moreover more frequent are poor pregnancy outcomes. PCOS ovarian function is influenced in several ways. Fertility may be impacted by overweight, hyperandrogenemia, and high LH. Androgen excess stimulates the deposition of visceral and abdominal adipose tissue, which induces insulin resistance (IR) and hyperinsulinemia and thus increases ovarian and adrenal gland androgen. IR, hyperinsulinemia, hyperandrogenism, and ovarian hypothalamic-pituitary dysfunction can all cause infertility (Li *et al.*, 2022).

Fertility is hampered in PCOS by anovulation, spontaneous abortion, reduced oocyte quality, elevated blood LH, and hyperinsulinemia-related losses. PCOS pregnancy is challenging due to endometrial hyperplasia, ovulatory dysfunction, and infertility. PCOS lowers conception rates independent of past performance. Among PCOS subjects hyperandrogenism symptoms are hirsutism, acne, and alopecia.

Overproducing androgen, ovaries and adrenal glands cause hyperandrogenism. PCOS women have raised gonadotropin-releasing hormone pulse frequency, which increases pituitary luteinizing hormone output above follicle-stimulating hormone production. While excess LH stimulates ovarian androgen synthesis, insufficient FSH causes follicular development to be delayed. In PCOS women, LH: FSH imbalance drives ovarian theca cell proliferation, steroidogenesis, and hyperandrogenism (Ganie *et al.*, 2019).

Common endocrine disease in women in reproductive age, PCOS results in hyperandrogenism, insulin resistance, and obesity. PCOS is correlated with insulin resistance and obesity. Women who are overweight or obese with PCOS may have hyperinsulinemia and IR. Most women with PCOS are thin and have IR and hyperinsulinemia. Hyperinsulinemia and β cell malfunction connected with PCOS raise the risk of metabolic abnormalities including type 2 diabetes (T2D), hypertension, dyslipidemia, and cardiovascular illnesses. Obesity aggravates metabolic and reproductive problems; PCOS patients commonly have metabolic comorbidities (Sanchez and Tena, 2020).

Controlling glucose homeostasis and lipogenesis is insulin's job. Mitogenic insulin affects protein synthesis, lipid, and glucose metabolism. Many HPO axis tissues feature insulin receptors that trigger insulin release. By raising ovarian and adrenal cortex trophic levels, insulin promotes steroidogenesis. Hyperinsulinemia produces more androgen since insulin mimics LH and indirectly increases GnRH. Insulin lowers a major testosterone regulator, SHBG. Low SHBG levels thereby raise free androgens, which aggravate acne, alopecia, and hirsutism. Research indicates that lowered insulin resistance lowers androgens and improves illness (Singh *et al.*, 2023). Women with PCOS often have low HDL cholesterol, dyslipidemia, high LDL and triglycerides. This lipid profile raises CVD risk (Guo *et al.*, 2022).

PCOS might influence anxiety and depression interactions. PCOS hormonal problems could cause depression and anxiety to get worse. Apart from physiological elements, PCOS sufferers may experience sadness and worry from keeping a chronic ailment, societal expectations, and fertility issues (Dewani *et al.*, 2023.). In the study of

Chaudhari and Friends (2018), PCOS women experienced 11 - 25per cent depression and 28-39 per cent anxiety.

Among PCOS symptoms are weight gain, acne, and hirsutism which affects self-esteem. Eating problems and low self-esteem can be brought on by PCOS. The standard of social beauty can aggravate these problems. Adoption of supportive therapy for physical and mental health depends on an awareness of how PCOS affects body image. Psychosocially, PCOS can affect romantic and familial relationships. Fertility concerns of PCOS sufferers can damage relationships and cause mental turmoil (Alur-Gupta *et al.*, 2019).

Lifestyle modification is the major preventive measure for PCOS. This includes diet management, physical exercise and psychological approaches. PCOS and hormonal abnormalities can be treated with various diets. Kamran and colleagues suggested PCOS diet should be hypocaloric, high fibre, protein, PUFA, low carbohydrates, low GI, low GL, and low fat. Reducing calories from 500 to 1000 for six months and reducing 7–10 per cent weight is advised. The ideal daily caloric intake is 1200–1400 kcal, with 40 per cent carbs, 30 per cent protein, and 30 per cent fat, predominantly omega-3 polyunsaturated fatty acids. This diet dramatically reduces weight, controls insulin, and improves PCOS (Kamran *et al.*, 2017). The modified diet should combat obesity and insulin resistance. Low-fat, plant-based diets assist 50-70 per cent of PCOS women lose weight and reduce insulin resistance (Chudzicka *et al.*, 2022). This is significant because insulin decreases SHBG and elevates free testosterone. Low-fat, high-fibre diets lower androgens, boost SHBG, and cure dyslipidemia (high triglycerides, low HDL), C-reactive protein, and homocysteine. Fruit, vegetable, whole grain, and legume diets reduce inflammation and oxidative stress (Wang *et al.*, 2005).

Inositol hexaphosphate helps encourage healthy grains, legumes, and nuts over processed carbohydrates. Inositol enhanced insulin action, lowered androgen, and improved ovulatory function in lean and obese PCOS women in clinical trials. Benefits from Metformin in PCOS may come from inositol availability (In Bernard, 2023). SCFAs were influenced by soluble fiber. Fermentable fiber releases SCFAs and enhances gut microbiota metabolism. A low-GI diet may influence ghrelin and

glucagon. PCOS women had decreased ghrelin and higher glucagon after low-GI meals (Hoover *et al.*, 2021).

The study by Szczuko *et al.* (2016) found that most women with polycystic ovary syndrome (PCOS) had an imbalanced diet. This diet was characterized by insufficient intake of fiber, omega-3 fatty acids, calcium, magnesium, zinc, and various vitamins, including folic acid, vitamin C, vitamin B12, and vitamin D. In contrast, their diet was high in sucrose, salt, total fats, saturated fats, and cholesterol. In PCOS women, most vitamin B increases plasma levels when supplemented with meals. Vitamin B3 did not affect this, and B2 and thiamine levels were lower than other vitamins (Szczuko *et al.*, 2021). Metformin normalizes PCOS glycemia, however long-term use depletes thiamine and cobalamin. Activating transketolase with thiamine decreases cardiovascular disease risk by blocking blood vessel-damaging processes (Eshak and Arafa, 2018).

Millets have a higher level of phenolic compounds, fibre, flavonoids, and phytosterols than other cereals, making them superior in terms of nutrients, health advantages, and phytochemical makeup. Through their prebiotic qualities, antioxidative processes, anti-inflammatory effects, and hypoglycemic profiles, these dietary components improve the health of the host. When we are considering the role of millet in PCOS, it is clear that these qualities are improving the PCOS condition. For PCOS, Ragi, Jowar, Bajra, and Korra millets are the best. These millets are helpful for PCOD and lower cholesterol and blood sugar levels. They are naturally free of gluten, which is good for PCOS. Iron, calcium, protein, and amino acids—all of which are essential for PCOS—are abundant in millet (Aprajita Verma and Dr. S C Khurana, 2020).

One of the crucial therapy approaches is weight loss. Independent treatment for PCOS women can be physical activity to evaluate all PCOS phenotypic traits (Sabag *et al.*, 2024). Genes, age, and personal hormonal condition are among the possible elements causing the predicted reaction to exercise. Early management recommendations for PCOS-related comorbidities include lifestyle modifications including physical activity modification since it lowers insulin resistance, improves metabolic and reproductive traits, and boosts self-esteem (Jiskoot *et al.*, 2017). While it improves sexual function and quality of life, aerobic exercise can help regulate

glycemic management (Lopes *et al.*, 2018). Because it reduces the likelihood of metabolic syndrome and its related clinical symptoms, physical activity helps PCOS women's reproductive health (Kaczmarek *et al.*, 2016). Apart from improving self-esteem and fertility in PCOS sufferers, physical exercise benefits mental health.

Skeletal muscle increases Glucose Transporter Type 4 (GLUT4) translocation to the plasma membrane to improve glucose absorption during exercise. Glucose transporter protein GLUT4 enables glucose pass the plasma membrane; insulin controls this process (Huang *et al.*, 2007). Research shows in an intensity- and volume-dependent way the significance of adenosine 5'-monophosphate (AMP)-activated protein kinase (AMPK), which controls post-exercise glucose absorption and insulin sensitivity. Furthermore, women with PCOS activate skeletal muscle insulin signaling and change insulin gene expression and metabolic signaling like in healthy women following an acute episode of exercise and also suggested that PCOS might impede the metabolic gains brought on by exercise (Stepto *et al.*, 2020).

Exercise increases Sex Hormone Binding Globulin (SHBG) levels, which bind to testosterone and hence affect its bioavailability in PCOS women (Patten *et al.*, 2022). Exercise can improve PCOS women's hyperinsulinaemia (Kite *et al.*, 2019) reduce impact androgen levels. High insulin levels can interfere with hepatic SHBG production, hence raising serum-free testosterone. The precise mechanisms by which exercise controls SBHG—including insulin levels—are uncertain. Furthermore improving PCOS ovarian function is exercise. Lean muscular mass/body fat lowers hormonal imbalances increases ovulation rates and regular menstrual cycles (Patten *et al.*, 2022). Consistent exercise lowers waist circumference, a clinical indicator of visceral fat (Breyley-Smith *et al.*, 2022). Few meta-analyses—Benham *et al.*, 2018; Richards *et al.*, 2021—have demonstrated changes in body weight or lipid profiles. Most meta-analyses find that fasting blood glucose does not improve; fasting insulin does.

PCOS and insulin resistance lower the mitochondrial activity of skeletal muscles, therefore influencing substrate metabolism and energy generation (Moreno-Asso *et al.*, 2022). Exercise increases mitochondrial activity and content, hence improving metabolic health (Malamouli *et al.*, 2022). By around one metabolic equivalent (~ 3.5

mL/kg/min), aerobic exercise—including Military Combat Training (MCT) or High-Intensity Interval Training (HIIT)—can increase cardiorespiratory fitness in women with PCOS (Breyley-Smith *et al.*, 2022). Scientific studies have shown that exercise can alleviate sadness and anxiety while also enhancing overall quality of life (Singh *et al.*, 2023). While active PCOS patients report fewer symptoms of depression than sedentary patients, the impact of exercise on mental health and quality of life in individuals with PCOS has not been thoroughly studied. Engaging in the appropriate type of exercise, at the right frequency and duration, is essential for women with PCOS to improve their mental health (Sabag *et al.*, 2024).

The reproductive health of young adult women, those between the ages of 18 and 21, is of the utmost importance for the preparation of a healthy and happy married life. Young adult women need to have proper nutrition care and support for their reproductive health, and they must also face a variety of challenges that will have an impact on their physical and mental health. The reason for this is that there is a lack of understanding regarding the significance of reproductive health and concerns, as well as the inadequate provision of care for it. Social awareness programs like Nutrition Interventions of Education and dietary supplementation help to make informed decisions regarding their physiology, reproductive health, relationships, and future family planning. Women often face difficulties accessing necessary healthcare facilities in various societies because of many reasons, such as social stigmas, lack of knowledge on nutrition and poor healthcare structure. Young adult women make choices that align with their personal aims and wishes by analysing these barriers and making accurate decisions, which help them to improve their quality of life.

Determining the prevalence of polycystic ovarian syndrome (PCOS) among young adult women was the main aim of the present study by assessing the sign and symptoms linked with this condition. Most of the women are not aware of their PCOS till they visit an infertility specialist. Here comes the importance of early diagnosis. Appropriate nutrition, help to prevent or minimize the consequences of severe symptoms of PCOS and encourage better reproductive results for women throughout their reproductive years. Nutrition interventions included physical exercise, nutrition education, and supplementation. This will be achieved by identifying and understanding early PCOS presence. This preventative approach places an emphasis not only on the

necessity of awareness but also on the necessity of making changes to one's lifestyle in order to forestall the onset of polycystic ovarian syndrome (PCOS) and other illnesses that are associated with it. The following objectives served as the basis for the research that was carried out.

Primary Objectives:

- To formulate and evaluate the nutrition education modules on PCOS and dietary supplements for PCOS for dietary supplementation.
- To evaluate the effect of nutritional interventions on symptoms of PCOS, Nutritional Status and nutritional knowledge of the selected PCOS subjects

Secondary Objectives

- To elicit the data related to socio-economic profile, dietary, water intake and lifestyle pattern of the study subjects (18 – 21 years).
- To screen the young adult women (18-21 years) using Rotterdam Criteria tool to identify PCOS subjects
- To assess the nutritional status using ABCD techniques for the selected subjects
- To evaluate the nutritional knowledge and attitude related to PCOS among subjects.
- To assess menstrual regularity, exposure to sunlight, stress level, menstrual hygiene and physical activity level of the selected PCOS study subjects

1.1 Novelty of the study

Most of the women are aware of this reproductive health issues only after reaching the infertility centres for treatment of regularizing their menstrual cycle.

1. Developed dietary supplement based on the nutritional needs and their health and nutritional status.
2. Included physical activities in nutrition interventions.
3. Created YouTube Channel and WhatsApp groups to educate and support PCOS Subjects in managing their reproductive health issues of PCOS.

There is a notable lack of localised nutritional research studies on PCOS among young adult women aged 18-21 years in Thrissur, Kerala. The present study will fill

this critical gap by assessing the effect of nutritional interventions including Nutrition Education, Physical Activity and Supplementation of Nutrient Dense Health Mix Powder on their nutritional knowledge and nutritional and health status of the selected study subjects.

1.2 Research Hypotheses

H0:1- Supplementation, Aerobic Exercise and Nutritional Education are not effective in promoting the reproductive health status of the study PCOS Subjects.

H0:2- Nutrition interventions do not reduce the stress level and do not regularize the menstrual cycle of the selected Study Subjects.

1.3 Scope of the Study

The present study is an intervention study which included Nutrition Education on PCOS, exercise and supplementation of Nutrient Dense Health Mix Powder. The knowledge they receive through Nutrition Education is serving as a cornerstone to improve their knowledge about PCOS, its symptoms and the significant role of exercise and nutrition in managing the condition of PCOS. The developed e-content of the nutrition Education module, including talks by experts like gynaecologists, dieticians, physical exercise trainers, Ayurveda and Homeo doctors helped to create awareness about the health and nutritional issues of PCOS and proper sustainable preventive measures helped to promote the healthy reproductive life. Introduction of the regular exercise as a part of the intervention is vital for improving weight management and PCOS management. Regular exercise is a true medicine for today's Lifestyle related diseases.

Additionally, dietary supplementation explored to enhance the effectiveness of the nutrition intervention. Frequent nutrition counselling helped to improve the macro and micro nutrient consumption. This study also studied the effect of macro and micro nutrient's intake on PCOS symptoms. Studying the relationship between dietary pattern, physical activity, and stress management helped to improve the quality of life of an individual with PCOS and advance the field of PCOS research. The findings of this

study spread the light for the further long term studies which help to develop community policies to manage and prevent PCOS and create a healthy community for the bright future.