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ORIGINAL ARTICLE OPEN ACCESS

The Influence of Clinical Nutrition and a Healthy Lifestyle on the Treatment of Polycystic Ovary Syndrome Symptoms

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ABSTRACT

Background: Polycystic ovary syndrome (PCOS) is the most common endocrinopathy among women, affecting approximately 1 in 15 globally. It is associated with a range of reproductive and metabolic dysfunctions, significantly impacting quality of life.

Objective: This study aimed to determine the prevalence of PCOS among female students at the University of Science and Technology, Aden, Yemen, and evaluate the effects of clinical nutrition and lifestyle interventions on mitigating PCOS symptoms.

Methods: This was a cross-sectional study and data was conducted between November 2020 and February 2021, comprising descriptive and experimental phases. Blood samples were collected and analyzed for hormonal levels (FSH and LH) at Almadeinah Medical Center, while complete blood count (CBC) parameters were assessed at the University's Faculty of Medicine and Health Sciences Laboratory.

Results: Of the 60 participants, 16 were diagnosed with PCOS, indicating a prevalence of 26.7%. Lifestyle and nutrition interventions led to significant improvement in PCOS-related symptoms, including reduced hair loss (P = 0.024), improvement in acne (P = 0.002), and better menstrual regulation (P = 0.002). While hormonal balance (FSH, LH) and CBC parameters (HB, WBC, Platelets) improved, the changes were not statistically significant.

Conclusion: This study highlights a substantial prevalence of PCOS among university students in Aden. It underscores the potential of clinical nutrition and lifestyle modifications as complementary, non-pharmacological strategies for managing PCOS symptoms and improving overall health. These findings suggest that prioritizing education on healthy habits and early lifestyle interventions could be critical in reducing the burden of PCOS and enhancing quality of life for affected women.

Keywords: Clinical Nutrition, Polycystic Ovary Syndrome, Healthy Lifestyle, Hormonal Balance, Reproductive Health

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INTRODUCTION

Polycystic Ovary Syndrome (PCOS) is a hormonal disorder that affects approximately 10% of females worldwide [1,2]. It is recognized as a heterogeneous endocrine condition with both reproductive and metabolic manifestations. The reproductive symptoms include anovulation, oligo-menorrhea/amenorrhea, infertility, and androgen excess, often evident as hirsutism. The metabolic features are marked by insulin resistance, dyslipidemia, and obesity [2,3]. Women with PCOS are at an increased risk of developing serious comorbidities, such as cardiovascular disease, dyslipidemia, hypertension, and type II diabetes [3-5]. Notably, PCOS is considered the most common gynecological disorder among premenopausal women, with a prevalence of 55.41% in this group [4]. Furthermore, PCOS is the leading cause of infertility in women of reproductive age, primarily due to anovulation [5-7].

Despite its prevalence, the pathogenesis of PCOS remains incompletely understood, often referred to as a "pathogenetic enigma." In 1993, Crowley et al. [8,9] proposed four credible pathogenetic hypotheses to explain the origins of PCOS. The first, known as the "top-down school," attributes PCOS to primary central dysregulation of luteinizing hormone (LH) production, which leads to inadequate follicular maturation, ovarian thecal cell hyperplasia, and increased androgen secretion. The second, the "bottom-up school," suggests that peripheral conversion of adrenal androgens (D4 androstenedione) into estrone in adipose tissue sensitizes the pituitary gland, causing it to hypersecrete LH and thereby enhance ovarian androgen production. The third hypothesis, the "androgen theory," posits that hyperandrogenism, originating from ovarian or adrenal sources, is the primary driver of PCOS. Lastly, the "insulin school" emphasizes the role of hyperinsulinemia and insulin resistance (IR) in the syndrome's pathophysiology. Hyperinsulinemia promotes hyperandrogenism and disrupts ovarian function by stimulating LH secretion, reducing levels of sex hormone-binding globulin (SHBG), and altering androgen clearance and steroidogenesis [7-12]. Among these, the metabolic component of PCOS, particularly IR and hyperinsulinemia, has garnered significant attention due to its role in exacerbating hyperandrogenism and chronic anovulation [13-17]. By reducing SHBG and increasing free androgens, hyperinsulinemia perpetuates PCOS symptoms and metabolic complications [18-22].

Lifestyle interventions have emerged as a cornerstone in managing PCOS, particularly in addressing metabolic alterations. Evidence suggests that lifestyle modifications, including weight management, dietary changes, and physical activity, improve body composition, hyperandrogenism, and insulin sensitivity in affected women [23]. Medical Nutrition Therapy (MNT), a tailored approach focusing on dietary and behavioral strategies, supports sustainable lifestyle changes that alleviate PCOS symptoms and reduce long-term complications [14].

The objective of this study is to investigate the effects of clinical nutrition and a healthy lifestyle on managing and alleviating the symptoms of PCOS, with a focus on improving metabolic and reproductive outcomes.

METHODS AND MATERIALS

This study was conducted in two parts: the first part focused on identifying the symptoms and prevalence of polycystic ovary syndrome (PCOS), while the second part was experimental, evaluating the effects of diet and a healthy lifestyle on managing PCOS symptoms.

First Part: Prevalence of PCOS

Sample Collection

Data were collected from 60 women aged 16 to 40, randomly selected from students and staff members of the University of Science and Technology, Aden, Yemen. A structured questionnaire was used to gather information on PCOS prevalence and

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associated factors, including age, social status, presence of PCOS symptoms, and family history.

Study Design

The study was conducted as a cross-sectional survey between November 1, 2020, and February 20, 2021, targeting reproductive-age women at the university.

Second Part: Experimental Study

Sample Collection

From the initial 60 participants, 16 women diagnosed with PCOS were selected for the experimental phase. This phase aimed to investigate the impact of clinical nutrition and a healthy lifestyle on alleviating PCOS symptoms.

Methodology

The experimental part included detailed data collection and analysis for the 16 women diagnosed with PCOS. Data collection methods included:

- **Structured Questionnaire**: A specific questionnaire was designed for the participants with PCOS. It was administered by the researcher to collect information on:
  - Medical history
  - Extent of PCOS symptoms (e.g., hair loss, acne, body hair growth)
  - Dietary habits
  - Mental health status
  - Physical activity level

The variables assessed in the questionnaire are summarized in Table 1:

- Age: Participant age in years.
- Family History: Presence or absence of PCOS in close relatives (Yes/No).
- Marital Status: Single or married.
- Stressful Lifestyle: Reported stress levels (Yes/No).
- Hair Loss: Graded as light, moderate, or heavy.
- Acne: Graded as light, moderate, or heavy.
- Body Hair: Graded as light, moderate, or heavy.
- Body Mass Index (BMI): Anthropometric measurements, including height, weight, and BMI, were taken before and after the nutrition intervention for comparison.

Table 1 : Distribution of variables as demographic n= 16

Variable		N (%)
Age (years)	25 +/- 2.6	
Family History	Yes	3 (18.7%)
	No	13 (0.81%)
Marital Status	Single	8 (50%)
	Married	8 (50%)
Stressful Lifestyle	Yes	6 (37.5%)
	No	10 (62.5%)
Hair Loss	Light	9 (56.2%)
	Reasonable	5 (31.25 %)
	Heavy	2 (12.5%)
Acne	Light	5 (31.25 %)
	Reasonable	7 (43.75%)
	Heavy	4 (25%)
Body Hair	Light	3 (18.7%)
	Reasonable	4 (25%)
	Heavy	9 (56.2%)

BMI is calculated by dividing one's weight in kilograms by the square of one's height in meters. According to WHO and NIH, BMI results are classified into three categories.

Table 2 : Body Mass Index Indicators

BMI	Results
Less than 18.5	**Under weight**
Above 18.5 and less than 25	**Normal**
Above 25 and less than 30	**Over weight**
More than 30	**Obesity**

Table 2: Body Mass Index (BMI) indicators.

- Menstrual days: regular, irregular.
- LH&FSH: normal, abnormal.

These two tests were done by Cobas 411

Table 3 Normal value for LH&FSH test in Cobas 411 device

Phase	LH	FSH

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Follicular phase	2.4 - 12.6	3.5 – 12.5
Ovulation phase	14.0 – 95.6	4.7 – 21.5
Luteal phase	1.0 – 11.4	1.7 – 7.7
Postmen phase	7.7 – 58.5	25.8 – 134

LH = luteinizing hormone FSH =follicle stimulating hormone

CBC: Normal and Abnormal Results

The Complete Blood Count (CBC) test was performed using the Celltac ES device.

- **Normal range** for the CBC test:
  - Hemoglobin (Hb): 6–15 g/dL
  - White Blood Cells (WBC): 3.4–9.6 billion cells/L
  - Platelets (PLT): 157–371 billion/L

Each participant was provided with a specialized diet tailored to her weight, height, age, and activity level. For eight weeks, the nutrients were allocated based on recommendations from previous studies: 15% protein [24], 25% lipids [25], and 60% low-glycemic index (GI) carbohydrates, including fiber [26, 27].

Blood Sample Collection

Venous blood (5 mL) was drawn from PCOS patients. A 2.5 mL portion was transferred to an EDTA tube containing an anticoagulant for CBC analysis. The remaining 2.5 mL was transferred to a plain screw-coated disposable plastic tube and left at room temperature for approximately 12 hours until it clotted and the clot retracted. After centrifugation at 3000 RPM for 3 minutes, the serum was separated and transferred to a new tube for the estimation of luteinizing hormone (LH) and follicle-stimulating hormone (FSH). The samples were transported on the same day to Almadeinah Medical Center in Aden, Yemen.

Statistical Analysis

Statistical analysis was conducted using IBM SPSS Statistics Version 23.

- **Qualitative variables:** Frequencies and percentages were analyzed using the Chi-Square and Fisher Exact tests.
- **Quantitative variables:** These were presented as means and standard deviations. The independent sample T-test was employed to compare groups. A p-value greater than 0.05 was considered statistically insignificant.

RESULT

In this study, we have applied a healthy lifestyle and diet control to 16 cases who suffer from PCOS at the University of Science and Technology in Aden, to show the effect of diet and healthy lifestyle on treating the symptoms of PCOS. Researchers drowned 60 females, of which 16 girls (26.7%) out of 60 had suffered from PCOS.

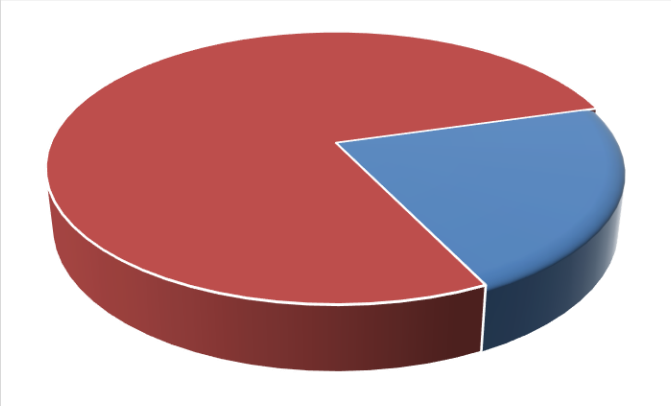

Figure 1: Distribution of female suffer from PCOS

Table 4. Distribution of Females Based on Age, Genetic Factors, and Social Status

Variables	No	%
Age (Mean ± SD)	25.31 ± 4.89	(20–36 years)
Family History		
Yes	90	56.25%
No	70	43.75%
Marital Status		
Single	100	62.5%
Married	60	37.5%

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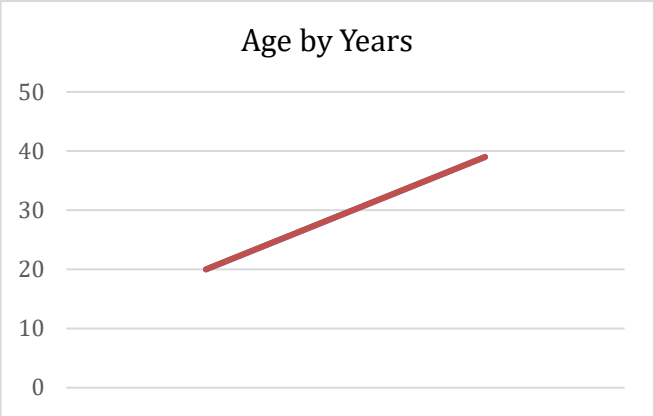

Figure 2: Distribution of the females according to the Age by years.

Table 5. Distribution of Females According to Stressful Lifestyle

Stressful Lifestyle	No	%
No	30	18.75
Yes	130	81.25
Total	160	100

Table 6. Distribution of Female Hair Loss Before and After Treatment in Relation to Diet Control

Hair Loss	Before	%	After	%
Light	60	37.5	110	68.8
Reasonable	60	37.5	50	31.2
Heavy	40	25	0	0
Total	160	100	160	100

Mean ± SD:
Before: 1.87 ± 0.80
After: 1.31 ± 0.47
P-value = 0.024

Interpretation: Table 6 demonstrates that diet and a healthy lifestyle were effective in the majority of cases. There was an improvement in hair loss, with 68.8% experiencing light hair loss after treatment, and 0% of participants having heavy hair loss. The difference in hair loss before and after diet control was statistically significant (p = 0.024).

Table 7. Distribution of Female Acne Before and After Treatment in Relation to Diet Control

Acne	Before	%	After	%
Light	120	75	130	81.3
Reasonable	20	12.5	30	18.2
Heavy	20	12.5	0	0
Total	160	100	160	100

P-value = 0.002

Interpretation: Table 7 indicates that diet and a healthy lifestyle contributed to noticeable improvements in acne. A majority of participants (81.3%) experienced light acne after treatment, and 0% had heavy acne. The difference in acne severity before and after treatment was statistically significant (p = 0.002).

Table 8. Distribution of Female Body Hair Before and After Treatment in Relation to Diet Control

Body Hair	Before	%	After	%
Light	100	62.5	130	81.3
Reasonable	30	18.75	20	12.5
Heavy	30	18.75	10	6.2
Total	160	100	160	100

Mean ± SD:
Before: 1.56 ± 0.81
After: 1.25 ± 0.58
P-value = 0.22

Interpretation: Table 8 shows that while there was an improvement in body hair, with 81.3% of participants reporting light body hair after diet control, there was no statistically significant difference in body hair (p = 0.22).

Table 9. Distribution of Female BMI Before and After Treatment in Relation to Diet Control

BMI	Before	%	After	%
Underweight	20	12.5	20	12.5
Normal	50	31.3	70	43.75
Obesity	90	56.2	70	43.75
Total	160	100	160	100

Mean ± SD:
Before: 26.13 ± 4.97

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After: 24.93 ± 4.73
P-value = 0.00

Interpretation: Table 9 indicates that diet control led to a significant improvement in BMI. The percentage of participants classified as obese decreased from 56.2% to 43.75%, while the proportion of those with normal BMI increased to 43.75%. The difference in BMI before and after treatment was statistically significant (p = 0.00).

Table 10. Distribution of Female Menstrual Days Before and After Treatment in Relation to Diet Control

Menstrual Days	Before	%	After	%
Regular	0	0	20	12.5
Irregular	160	100	140	87.5
Total	160	100	160	100

Mean ± SD:
Before: 59.06 ± 30.12
After: 30.75 ± 8.37
P-value = 0.002

Interpretation: Table 10 shows that diet and a healthy lifestyle contributed to a reduction in irregular menstrual days by 87.5%, while regular menstrual days increased by 12.5%. The difference was statistically significant (p = 0.002).

Table 11. Distribution of Female LH and FSH Levels Before and After Treatment in Relation to Diet Control

Hormonal Level	Before	%	After	%
LH (Abnormal)	70	45.8	10	6.3
LH (Normal)	90	56.2	150	93.7
FSH (Abnormal)	20	12.5	0	0
FSH (Normal)	140	87.5	160	100
Total	160	100	160	100

Mean ± SD:
LH: 16.20 ± 16.64 (Before), 9.48 ± 5.20 (After)
FSH: 6.18 ± 2.63 (Before), 9.42 ± 1.22 (After)
P-value (LH) = 0.166, P-value (FSH) = 0.574

Interpretation: Table 11 shows that diet and a healthy lifestyle led to an improvement in both LH and FSH levels. Most cases showed normal LH (93.7%) and FSH (100%) after treatment, but the differences were not statistically significant (p = 0.166 and p = 0.574, respectively).

Table 12. Distribution of Female CBC Levels Before and After Treatment in Relation to Diet Control

CBC Test	Before	%	After	%
Hb (Normal)	0	0	50	31.3
Hb (Abnormal)	160	100	110	68.8
WBC (Normal)	10	6.3	160	100
WBC (Abnormal)	150	93.7	0	0
Platelets (Normal)	10	6.3	160	100
Platelets (Abnormal)	150	93.7	0	0
Total	160	100	160	100

Mean ± SD:
Hb: 12.16 ± 1.12 (Before), 12.56 ± 0.92 (After)
WBC: 6.16 ± 1.86 (Before), 5.85 ± 1.6 (After)
Platelets: 325.48 ± 74.51 (Before), 316.17 ± 19.81 (After)
P-value = 0.411, 0.724, 0.652

Interpretation: Table 12 shows a positive influence of diet and a healthy lifestyle on CBC parameters. Hb improved with fewer abnormal results (68.8%), while WBC and platelets were completely normalized (100%) after the diet. However, the differences in Hb, WBC, and platelets before and after treatment were not statistically significant (p = 0.411, p = 0.724, p = 0.652).

DISCUSSION

Polycystic Ovary Syndrome (PCOS) is a multifaceted condition characterized by enlarged ovaries with numerous cysts or follicles that fail to mature and produce eggs capable of being fertilized. This condition is relatively common, especially among infertile women [1]. PCOS is associated with an endocrine imbalance resulting in elevated levels of

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estrogen, testosterone, and luteinizing hormone (LH), while follicle-stimulating hormone (FSH) secretion is reduced. These hormonal imbalances lead to disruptions in the hypothalamic-pituitary-ovarian axis and may be linked to androgen-producing tumors [2, 3]. PCOS affects approximately 12–21% of women of reproductive age, with up to 70% of women remaining undiagnosed [4]. It is a major cause of oligo-ovulatory infertility, impacting about 4% of women of reproductive age [28].

Lifestyle changes, particularly diet modifications, remain a critical concern for young women with PCOS. The first-line treatment continues to focus on lifestyle interventions aimed at mitigating long-term complications [29].

Sample Characteristics and Genetic Factors

Table 3 shows the mean age of the study sample as 25.31 years, with a range of 20 to 36 years. The table also reveals that 56.25% of participants had a family history of PCOS. The genetic component of PCOS is well-documented, with several studies supporting a familial predisposition to the condition [30, 31]. In 2014, Lerchbaum et al. [32] demonstrated that a positive family history of PCOS was independently associated with clinical signs of hyperandrogenism and prediabetes.

Stress and Lifestyle Factors

Table 4 highlights that 81.25% of the study participants reported a stressful lifestyle. A 2018 study [33] found that PCOS symptoms could significantly worsen quality of life, with stress being a major contributing factor. This aligns with other studies that suggest stress plays a critical role in exacerbating PCOS symptoms.

Impact of Diet on Hair Loss and Acne

Table 5 shows a statistically significant improvement in hair loss following the dietary intervention, with a P-value of 0.024. Prior to the nutritional intervention, 25% of participants experienced heavy hair loss. Table 6 reveals that acne symptoms also improved significantly, with a P-value of 0.002. This contrasts with a 2004 review, which found no conclusive evidence on the effect of diet on acne [34]. However, our study aligns with other research, such as a study that reported a 32.1% reduction ($p = 0.004$) in acne symptoms after following a low-GI diet [35].

Effect of Diet on Body Hair

Table 7 indicates a decrease in the prevalence of body hair growth, from 18.75% before dietary intervention to 6.2% after intervention. However, this change was not statistically significant ($P > 0.05$). Janssen et al. [36] found that hirsutism is often associated with anxiety and psychotic symptoms. Given that 81.25% of participants reported a stressful lifestyle, it is possible that psychological factors may influence the severity of hirsutism in this population.

Impact of Diet on Body Mass Index (BMI)

Table 8 shows a significant relationship between diet and weight loss, with a P-value of 0.00. The percentage of obese participants decreased from 56.2% before dietary intervention to 43.75% after. Numerous studies have demonstrated that weight loss improves metabolic and reproductive outcomes in overweight and obese women with PCOS [28]. Lifestyle modifications, including dietary changes, exercise, and behavioral adjustments, have been shown to improve hormone levels, metabolism, and clinical features in patients with PCOS. In fact, weight loss alone can normalize many hormonal imbalances, alleviating symptoms of PCOS. Furthermore, adopting healthy eating habits and regular exercise can prevent further weight gain and improve long-term health outcomes [31].

Menstrual Regularity and Hormonal Changes

Table 9 shows a slight improvement in menstrual regularity, with a 12.5% increase in the proportion of women experiencing regular menstrual cycles. However, although the difference in the mean number of menstrual days before and after the

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dietary intervention was notable (59 days versus 30 days), the change was not statistically significant. Marsh et al. [29] (2010) reported improved menstrual cyclicity with a low-GI diet (95% compared to 63%; P = 0.03). Many studies have similarly shown that lifestyle changes, particularly those improving insulin sensitivity, result in better menstrual regularity and ovulation [37, 38, 39, 40].

Hormonal Response to Diet

Table 10 shows improvements in hormonal levels following dietary intervention. The percentage of women with abnormal LH levels decreased from 45.8% to 6.3%, and abnormal FSH levels dropped from 12.5% to 0%. Despite these changes, the differences were not statistically significant (P = 0.166 for LH and P = 0.574 for FSH). These findings are consistent with those of Mehrabani et al. [41], who observed no significant changes in hormone levels in response to a low-GI diet in women with PCOS.

Complete Blood Count (CBC) Results

Table 11 indicates improvements in CBC test results (Hb, WBC, platelets), but none of the changes were statistically significant (P = 0.411 for Hb, P = 0.724 for WBC, P = 0.652 for platelets). Despite these findings, it is evident that the diet and lifestyle intervention did not have any negative impact on the participants' general blood profile.

CONCLUSIONS

This study demonstrates that a balanced diet and healthy lifestyle modifications can have significant positive effects on several symptoms associated with Polycystic Ovary Syndrome (PCOS), including hair loss, acne, and body mass index (BMI) in women. Our findings suggest that lifestyle interventions, particularly those involving dietary adjustments, lead to improvements in clinical features such as acne and hair growth, with statistically significant reductions in hair loss and acne severity.

Moreover, the study highlights the beneficial impact of diet on reducing obesity, a major concern for women with PCOS, and supports previous research indicating that weight loss improves hormonal balance and metabolic health. Although changes in menstrual regularity and hormonal levels (LH, FSH) were observed, the improvements were not statistically significant. This suggests the need for further studies with larger sample sizes or longer intervention periods to more fully assess the hormonal effects of dietary control.

Importantly, this study reinforces the critical role of diet and lifestyle in managing PCOS symptoms, especially in overweight or obese patients, as part of a holistic approach to treatment. While the changes in complete blood count (CBC) parameters did not show significant statistical differences, there was no adverse impact, indicating that dietary modifications did not negatively affect general health.

In conclusion, the implementation of a controlled diet and healthy lifestyle can be an effective non-pharmacological approach to managing PCOS symptoms. Further research is needed to explore the long-term effects of such interventions and to refine strategies for managing hormonal imbalances and reproductive health in PCOS patients.

Based on the overall findings of the present study, it can be concluded that the results support the hypothesis that lifestyle changes positively affect the reduction of symptoms associated with polycystic ovarian syndrome. This study recommends the following:

1. **Implications for Nurses and Healthcare Providers**: It is important for healthcare providers to be aware of young Yemeni women's reluctance to seek help. They should actively promote the benefits of lifestyle changes and ensure supportive follow-up to enhance compliance and outcomes.
2. **Replication of the Study**: Future research should replicate this study with a larger sample size across different institutions to further validate the findings.

3. **Further Research Directions**: Additional studies should focus on identifying optimal dietary strategies and exercise regimens for PCOS treatment. It is also crucial to compare the relative efficacy of lifestyle management against pharmacological treatments (such as anti-obesity agents) and surgical interventions.

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Ethical Approval

This study was conducted in accordance with the ethical guidelines set forth by the University of Science and Technology, Aden, Yemen number (MEC No/AD040). Ethical approval was obtained from the Institutional Review Board (IRB) or Ethics Committee before the initiation of the study. All participants were fully informed about the study's aims, procedures, and potential risks, and written informed consent was obtained from each participant prior to their inclusion in the study. The confidentiality and anonymity of the participants were maintained throughout the research process, and the study adhered to ethical principles for research involving human subjects.

REFERENCES

[1] Stein K. Polycystic ovarian syndrome: what it is and why registered dietitians need to know. *J Am Diet Assoc.* 2006;106(11):1738-41.

[2] Vargas ML, Almario RU, Buchan W, Kim K, Karakas SE. Metabolic and endocrine effects of long-chain versus essential omega-3 polyunsaturated fatty acids in polycystic ovary syndrome. *Metabolism.* 2011;60(12):1711-8.

[3] Dokras A, Bochner M, Hollinrake E, Markham S, VanVoorhis B, Jagasia DH. Screening women with polycystic ovary syndrome for metabolic syndrome. *Obstet Gynecol.* 2005;106(1):131-7.

[4] Zafar U, Memon Z, Moin K, Agha S, Hassan JA, Zehra D. Prevalence of PCOS with associated symptoms and complications at a tertiary care hospital of Karachi. *J Adv Med Med Res.* 2019;30(4):1-9.

[5] Legro RS, Arslanian SA, Ehrmann DA, Hoeger KM, Murad MH, Pasquali R, et al. Diagnosis and treatment of polycystic ovary syndrome: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab.* 2013;98(12):4565-92.

[6] Crowley WF Jr, Hall JE, Martin KA, Adams J, Taylor AE. An overview of the diagnostic considerations in polycystic ovarian syndrome. *Ann N Y Acad Sci.* 1993;687:235-41.

[7] Lanzone A, Fulghesu AM, Guido M, Fortini A, Caruso A, Mancuso S. Differential androgen response to adrenocorticotropic hormone stimulation in polycystic ovarian syndrome: relationship with insulin secretion. *Fertil Steril.* 1992;58:296-301.

[8] Nestler JE, Usiskin KS, Barlascini CO, Welty DF, Clore JN, Blackard WG. Suppression of serum insulin by diazoxide reduces serum testosterone levels in obese women with polycystic ovary syndrome. *J Clin Endocrinol Metab.* 1989;68:1027-32.

[9] Nestler JE, Powers LP, Matt DW. A direct effect of hyperinsulinemia serum sex-hormone-binding globulin levels in obese women with the polycystic ovary syndrome. *J Clin Endocrinol Metab.* 1991;72:83-9.

[10] Ciampelli M, Lanzone A. Insulin and polycystic ovary syndrome. *Gynecol Endocrinol.* 1998;12:277-92.

[11] Moghetti P, Castello R, Negri C. Insulin infusion amplifies 17 alpha-hydroxycorticosteroid intermediates response to adrenocorticotropin in hyperandrogenic women: apparent relative impairment of 17,20-lyase activity. *J Clin Endocrinol Metab.* 1996;81:881-6.

[12] Speca S, Napolitano C, Tagliaferri G. *J Ultrasound.* 2007;10(4):153-60.

[13] Moran LJ, Hutchison SK, Norman RJ, Teede HJ. *Cochrane Database Syst Rev.* 2011;(2).

[14] Dennett CC, Simon J. *Diabetes Spectr.* 2015;28(2):116-20.

[15] Ba-abbad AM, Maknoon AA, Bin-Zaidan YK. Detection of milk's sheep quality indicators by studying the contamination of milk with some heavy metals in some areas of Hadramout Coast–Yemen. *Yemeni J Med Sci* [Internet]. 2024 [cited 2024 Nov 16];18(1):9-19. Available from: https://journals.ust.edu/index.php/yjms/article/view/2322

[16] Ali IN, Awad MM, Mahmood AS. Effect of methotrexate and omega-3 combination on cytogenetic changes of bone marrow and some enzymatic antioxidants: an experimental study. *Yemeni J Med Sci* [Internet]. 2017 [cited 2024 Nov 16];11(1):1-7. Available from: https://journals.ust.edu/index.php/yjms/article/view/1059

[17] Alhaj A, Alqubaty AR, Nassar M, Al-qadasi F. Assessment of certain biochemical parameters among petrol station workers in Sana'a City, Yemen. *Yemeni J Med Sci* [Internet]. 2018 [cited 2024 Nov 16];12(1):44-50. Available from: https://journals.ust.edu/index.php/yjms/article/view/1426

[18] Zacur HA. Epidemiology, clinical manifestations, and pathophysiology of polycystic ovary syndrome. *Adv Stud Med.* 2003;3

[19] Bentley-Lewis R, Seely E, Dunaif A. Ovarian hypertension: polycystic ovary syndrome. *Endocrinol Metab Clin North Am.* 2011;40(2):433-49.

[20] Zueff LFN, Martins WP, Vieira CS, Ferriani RA. Ultrasonographic and laboratory markers of metabolic and cardiovascular disease risk in obese women with polycystic ovary syndrome. *Ultrasound Obstet Gynecol.* 2012;39(3):341-7.

[21] Melo AS, Dias SV, Cavalli RC, Cardoso VC, Bettiol H, Barbieri MA, et al. Pathogenesis of polycystic ovary syndrome: multifactorial assessment from the foetal stage to menopause. *Reproduction.* 2015;150(1)

[22] .

[23] Witchel SF, Recabarren SE, González F, Diamanti-Kandarakis E, Cheang KI, Duleba AJ, et al. Emerging concepts about prenatal genesis, aberrant metabolism and treatment paradigms in polycystic ovary syndrome. *Endocrine.* 2012;42(3):526-34.

[24] Ehrmann DA. Polycystic ovary syndrome. *N Engl J Med.* 2005;352(12):1223-36.

[25] Farshchi H, Rane A, Love A, Kennedy RL. Diet and nutrition in polycystic ovary syndrome (PCOS): pointers for nutritional management. *J Obstet Gynaecol.* 2007;27(8):762-73.

[26] Marsh K, Brand-Miller J. The optimal diet for women with polycystic ovary syndrome? *Br J Nutr.* 2005;94(2):154-65.

[27] Atiomo W, Read A, Golding M, et al. Local recruitment experience in a study comparing the effectiveness of a low glycaemic index diet with a low calorie healthy eating approach at achieving weight loss and reducing the risk of endometrial cancer in women with polycystic ovary syndrome (PCOS). *Contemp Clin Trials.* 2009;30(5):451-6.

[28] Moran LJ, Noakes M, Clifton PM, Tomlinson L, Galletly C, Norman RJ. Dietary composition in restoring reproductive and metabolic physiology in overweight women with polycystic ovary syndrome. *J Clin Endocrinol Metab.* 2003;88(2):812-7.

[29] Marsh KA, Steinbeck KS, Atkinson FS, Petocz P, Brand-Miller JC. Effect of a low glycemic index compared with a conventional healthy diet on polycystic ovary syndrome. *Am J Clin Nutr.* 2010;92(1):83-92.

[30] Gambineri A, Pelusi C, Vicennati V, Pagotto U, Pasquali R. Obesity and the polycystic ovary syndrome. *Int J Obes Relat Metab Disord.* 2002;26(7):883-96.

[31] Franks S, McCarthy M. Genetics of ovarian disorders: polycystic ovary syndrome. *Rev Endocr Metab Disord.* 2004;5(1):69-76.

[32] Wojciechowski P, Lipowska A, Rys P, Ewens KG, Franks S, Tan S, et al. Impact of FTO genotypes on BMI and weight in polycystic ovary syndrome: a systematic review and meta-analysis. *Diabetologia.* 2012;55(10):2636-45.

[33] Kahsar-Miller M, Azziz R. The development of the polycystic ovary syndrome: family history as a risk factor. *Trends Endocrinol Metab.* 1998;9(2):55-8.

[34] Escobar-Morreale HF, Luque-Ramírez M, San Millán JL. The molecular-genetic basis of functional hyperandrogenism and the polycystic ovary syndrome. *Endocr Rev.* 2005;26(3):251-82.

[35] Lerchbaum E, Schwetz V, Giuliani A, Obermayer-Pietsch B. Influence of T2DM and PCOS family history in PCOS women. *Eur J Endocrinol.* 2014;170(5):727-39.

[36] Behboodi Moghadam Z, Fereidooni B, Saffari M, Montazeri A. Measures of health-related quality of life in PCOS women: a systematic review. *Int J Womens Health.* 2018;10:397-408.

[37] Wolf R, Matz H, Orion E. Acne and diet. *Clin Dermatol.* 2004;22(5):387-93.

[38] Shishehgar F, Mirmiran P, Rahmati M, Tohidi M, Ramezani Tehrani F. Does a restricted energy low glycemic index diet have a different effect on overweight women with or without polycystic ovary syndrome? *BMC Endocr Disord.* 2019;19(1):42.

[39] Janssen OE, Hahn S, Tan S, Benson S, Elsenbruch S. Mood and sexual function in polycystic ovary syndrome. *Semin Reprod Med.* 2008;26(1):45-52.

[40] Tolino A, Gambardella V, Caccavale C, et al. Evaluation of ovarian functionality after a dietary treatment in obese women with polycystic ovary syndrome. *Eur J Obstet Gynecol Reprod Biol.* 2005;119(1):87-93.

[41] Huber-Buchholz MM, Carey DG, Norman RJ. Restoration of reproductive potential by lifestyle modification in obese polycystic ovary syndrome: role of insulin sensitivity and luteinizing hormone. *J Clin Endocrinol Metab.* 1999;84(4):1470-4.

[42] Mehrabani HH, Salehpour S, Amiri Z, Farahani SJ, Meyer BJ, Tahbaz F. Beneficial effects of a high-protein, low-glycemic-load hypocaloric diet in overweight and obese women with polycystic ovary syndrome: a randomized controlled intervention study. *J Am Coll Nutr.* 2012;31(2):117-25.

[43] Velazquez EM, Mendoza S, Hamer T, Sosa F, Glueck CJ. Metformin therapy in polycystic ovary syndrome reduces hyperinsulinemia, insulin resistance, hyperandrogenemia, and systolic blood pressure, while facilitating normal menses and pregnancy. *Metabolism.* 1994;43(5):647-54.

[44] Salim SG, Ali AB, Qaid TW, Alqawy SA, Al-shawafi SE, Awadh SA, et al. Minimum dietary diversity among women of reproductive age (15-49 years) in Sheikh Othman District, Aden Governorate-Yemen. *Med Sci Acad J Multidiscip.* 2024;1(1):1-9.