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Original Research Article

A Study of Correlation of BMI, TSH Levels and HbA1c among Diagnosed PCOS Females

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Abstract:
Polycystic ovary syndrome (PCOS) is a common endocrine disorder affecting reproductive-aged women. It is associated with metabolic abnormalities such as obesity, insulin resistance, and thyroid dysfunction. This study aims to evaluate the correlation between body mass index (BMI), thyroid-stimulating hormone (TSH) levels, and glycated hemoglobin (HbA1c) among women females diagnosed with PCOS aged between 18 - 50 yrs. Menstrual irregularities and infertility are more prevalent in obese PCOS women. Obesity is also closely associated with PCOS, which affects 6–12% of women of reproductive age. A cross-sectional study was conducted involving 100 women aged 18 - 50 yrs diagnosed with PCOS based on Rotterdam criteria. Data on BMI, TSH levels, and HbA1c were collected and analyzed to assess correlations using SPSS paired t- test, 2-tailed spearman correlation. In present study, it was found that TSH has positive correlation with BMI(r=0.3, p=0.002). HbA1C has positive correlation with BMI (r=0.266, p=0.007). TSH has a positive correlation with HbA1C (r=0.29, p=0.003). In conclusion this study shows the significant correlation between BMI, TSH levels and HbA1c among diagnosed PCOS females. These correlations emphasize the need for integrated management strategies targeting obesity, thyroid dysfunction, and insulin resistance to improve metabolic outcomes in this population.
Keywords: PCOS, BMI, TSH, HbA1c, Metabolic Dysfunction.

Introduction

Polycystic ovary syndrome (PCOS) is a heterogeneous, multisystem endocrinopathy in women of reproductive age manifested with various metabolic disturbances and a wide spectrum of clinical features such as obesity, menstrual abnormalities and hyperandrogenism.[1] Menstrual irregularities and infertility are more prevalent in obese PCOS women. Obesity is also closely associated with PCOS, which affects 6–12% of women of reproductive age.[2] PCOS does not have a single diagnostic marker to provide a gold standard for reference. The consensus-based diagnostic criteria for PCOS in the Rotterdam criteria have defined the disease and, as such, have been valuable both clinically and scientifically.[3] It is recommended to use the modified Rotterdam criteria, (see Table 1) in which PCOS may be diagnosed if any two of the following are present:

1. clinical or biochemical hyperandrogenism,
2. evidence of oligo-anovulation,
3. polycystic appearing-ovarian morphology on ultrasound, with exclusion of other relevant disorders. [4]

Features of the diagnosis of PCOS.

Table 1:

Feature	Recommended Diagnosis	Considerations
Biochemical Hyperandrogenism	Elevated total or free testosterone, or calculated indices of free testosterone (FAI, BioT). DHEAS and ANSD can be consdered	High-quality assays should be used for the evaluation of analytes
Clinical Hyperandrogenism	A modified Ferriman–Gallwey score of ≥4 to ≥8	Threshold level should be considered in the context of patient ethnicity
Oligo-anovulation	Oligo-amenorrhea (cycles >35 days apart or <8 menses a year)	If highly suspicious for PCOS, but does not have oligo-amenorrhea, consider serum progesterone or luteinizing hormone assessment

Polycystic ovarian morphology	≥20 follicles per ovary in either ovary ≥10 cm^3 ovarian volume	Based on transvaginal ultrasonography with a transducer frequency ≥ 8 MHz

Criteria based on the modified 2003 Rotterdam criteria. FAI—free androgen index, BioT—bioavailable testosterone, DHEAS—dehydroepiandrosterone sulfate, ANSD—androstenedione. [4] The prevalence of obesity in PCOS ranges from 38% to 87%. It was reported that in obese PCOS women, the prevalence of IR (Insulin resistance)was higher than obese women without PCOS in the control group.(1)Women with PCOS are at increased risk of developing type II diabetes. Inreased insulin leads to increased androgen production from the ovarian thecal cells and this hyperandrogenemia is responsible for androgenic obesity. [5] Hyperinsulinemia was noted in 50% to 70% of PCOS patients and plays a central role in the development of further complications.[1] Recently, different studies from various parts of the world regarding hypothyroidism in PCOS patients have tried to explore the PCOS–thyroid interface. Most of the results have shown a higher incidence of elevated serum thyroid-stimulating hormone (TSH) levels in PCOS subjects. The raised TSH levels are associated with the rapid production of fat cells either by inflammatory mediators or via another hormone called leptin, thereby leading to obesity. [6] HbA1c in circulation is an indicator of blood glucose control. HbA1c widely used as a long term glycemic index to monitor blood glucose over the past 8 weeks or more.[5] For an HbA1c test to classify as normal, or in the non-diabetic range, the value must be below 5.7%. Anyone with an HbA1c value of 5.7% to 6.4% is considered to be prediabetic, while diabetes can be diagnosed with a HbA1c of 6.5% or higher.[7] The main aim of this study is to find the correlation between the BMI, TSH levels and HbA1c among the diagnosed PCOS females. This study is performed on population of 100 diagnosed PCOS females aged between 18 - 50.

Material and Methods

1. **Study Design:** A Cross-sectional study
2. **Study Setting:**
3. **Study Population:** The present study is conducted on diagnosed PCOS females aged in between 18-50.
4. **Sample Size:** The sample size of the present study is 100
5. **Sampling Technique:**
6. **Data Collection Procedure:** Data collection will be done using standardized Data collection forms that include following variables Demographic information (age, ethnicity, etc.)

- Medical history and PCOS characteristics (age at diagnosis, menstrual irregularities, androgen levels).
- BMI measurements (height and weight) are obtained using caliberated instruments.
- HbA1c levels are obtained from blood samples collected in fasting state.

Inclusion Criteria:

Females diagnosed with PCOS based on Rotterdam criteria.

According to the Rotterdam criteria, a female is diagnosed as PCOS if any 2 of the following are present.

(1) clinical or biochemical hyperandrogenism,
(2) evidence of oligo-anovulation,
(3) polycystic appearing-ovarian morphology on ultrasound, with exclusion of other relevant disorders.

Exclusion Criteria: Female PCOS patients with anemia since it affects HbA1c formation PCOS on medication.

Study Tool: BMI measurement is done using the formula- weight(kg)/height^2(m^2). Height and weight are measured using calibrated instruments.

HbA1c levels are obtained from blood samples using "high performance liquid chromatography (HPLC)" method collected in fasting state.

TSH levels are collected from blood samples using "Immunochemiluminescence technique (LIA)" during 1st to 3rd day of menstrual cycle in fasting state.

Data Analysis: Statistical analysis is done using Microsoft excel spss paired test.

Ethical Issues: An approval from the Institutional Ethics Committee (REG>NO: IEC/RMC/2023/042/UG) was taken before initiating the study. Informed consent (annexure) was taken from all participants, and fully confidentiality was maintained.

Results

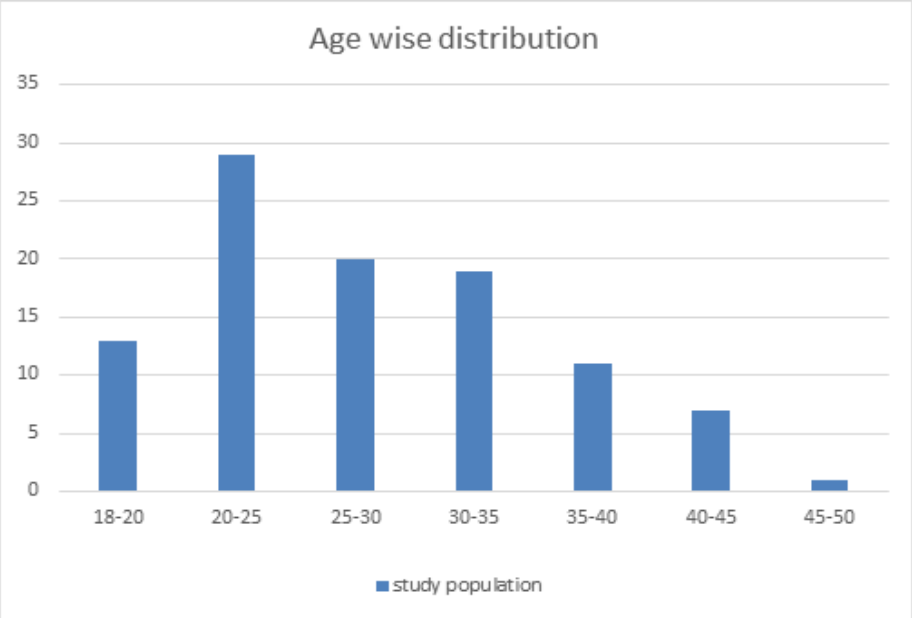
The study population of the present study is 100 aged between 18-45.

Age Wise Distribution: Out of the study population of 100, the maximum age is 50 and minimum age is 18 years. The age is divided into 7 groups as 18-20 years, 20-25 years, 25- 30 years, 30 – 35 years, 35-40 years, 40-45 years, 45-50 years. It is observed that the maximum Percentage of the study population that is 29% belongs to the age group 20-25 years, 20% of the study population belongs to the age group 25-30 years, 19% of the study population belongs to the age group 30 -35 years, 13% of the study population belongs to the age group 18-20

years, 7% of the study population belongs to the age group 40-45 years, 15% of the study population belongs to the age group of 45-50 years of age. The details are shown in the following table and figure.

Table 2:

Age Group	Study Population (N=100)	Percentage
18-20	**13**	**13%**
20-25	**29**	**29%**
25-30	**20**	**20%**
30-35	**19**	**19%**
35-40	**11**	**11%**
40-45	**7**	**7%**
45-50	**1**	**1%**

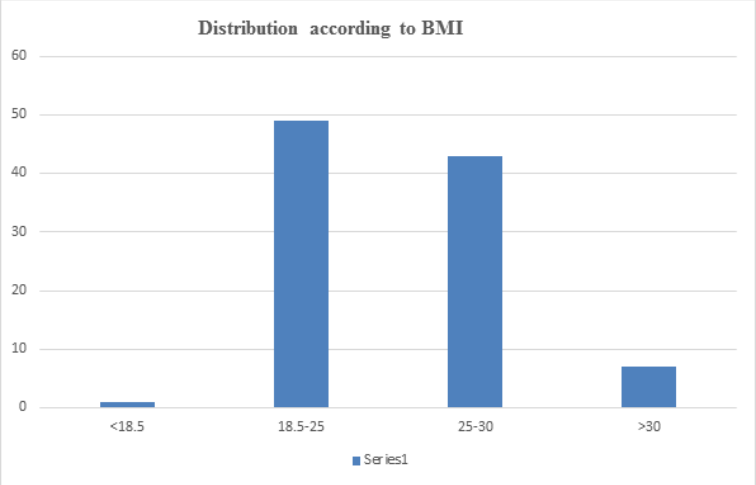


Graph 1: Age wise distribution

Distribution according to BMI: The BMI of the study population is measured according to the standard formula. In this study, the maximum Percentage of the study population thar is 49% fall into normal range where the BMI is ranges between 18.5-25. 43% of the study population are overweight where the BMI ranges in between 25- 30. 7% of the study population are obese with BMI greater than 30.1% of the study population are Underweight with BMI less than 18.5. The details are given in the following table and graph.

Table 3:

Weight status	BMI	Population size	Percentage
Underweight	**<18.5**	**1**	**1%**
Normal range	**18.5-25**	**49**	**49%**
Overweight	**25-30**	**43**	**43%**
Obese	**>30**	**7**	**7%**

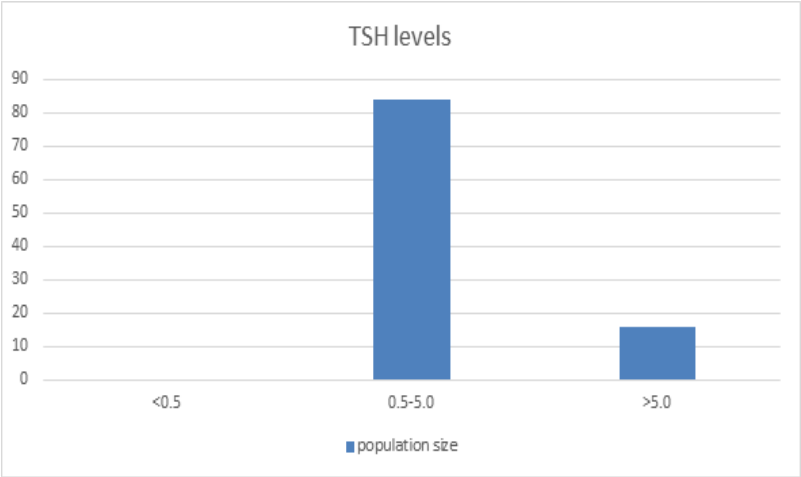


Graph 2: Distribution according to BMI

TSH Levels: The study population is divided in groups based on the TSH levels in the blood. The population is divided into 3 groups, whose TSH level is below 0.5mlU/L, TSH levels in between 0.5 – 5.0 mlU/L, TSH levels above 0.5 mlU/L. 84% of the study population have normal TSH levels, 16% of the study population has elevated TSH levels i.e., more than 0.5mlU/L. The details are given in the following table and graph.

Table 4: TSH Levels

TSH Levels	Population size	Percentage
<0.5	**0**	**0%**
0.5-5.0	**84**	**84%**
>5.0	**16**	**16%**

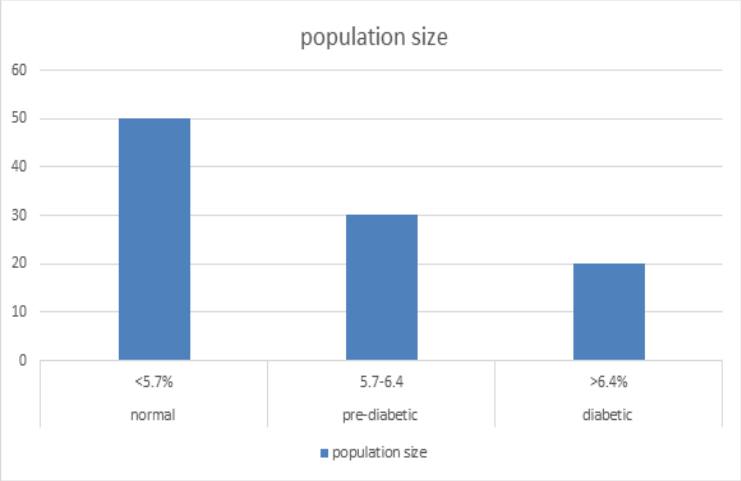


Graph 3: TSH Levels

Distribution according to HbA1C Levels: In this present study of study population 100, the maximum population, 50% of the study population were in normal range with HbA1C Levels ranging less than 5.7%. 30% of the study population were pre-diabetic with HbA1C ranging in between 5.7-6.4%. 20% of the study population are diabetic with HbA1C Levels greater than 6.4%. The details are given in the following table and graph.

Table 5:

Range	HbA1C Levels	Population size	Percentage
Normal	**<5.7**	**50**	**50%**
Pre-diabetic	**5.7-6.4**	**30**	**30%**
Diabetic	**>6.4**	**20**	**20%**

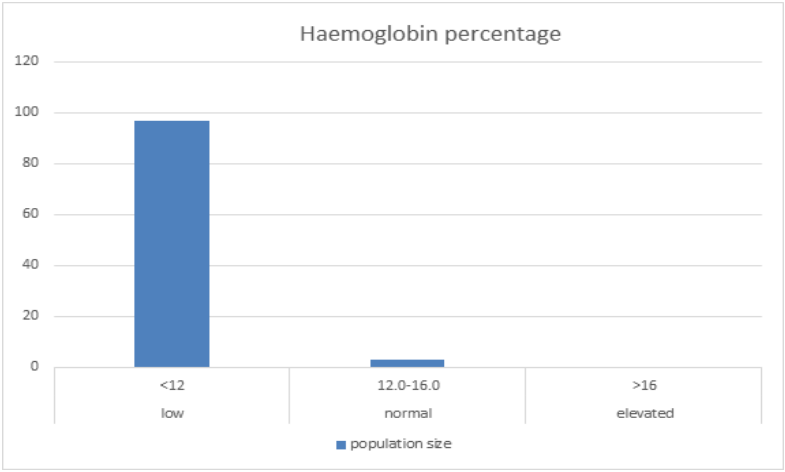


Graph 4: Population size

Distribution according to the Haemoglobin Percentage: The Haemoglobin values of the study population were recorded. Put of 100 study population, maximum people which is 97% of the study population have low levels of Haemoglobin i. e., less than 12g/dl. Only 3% of the study population has normal Levels of haemoglobin ranging between 12-16 g/dl.

Table 6:

Hb Levels	Hb percentage	Population size	Percentage
Low	<12	97	97%
Normal	12-16	3	3%
Elevated	>16	0	0

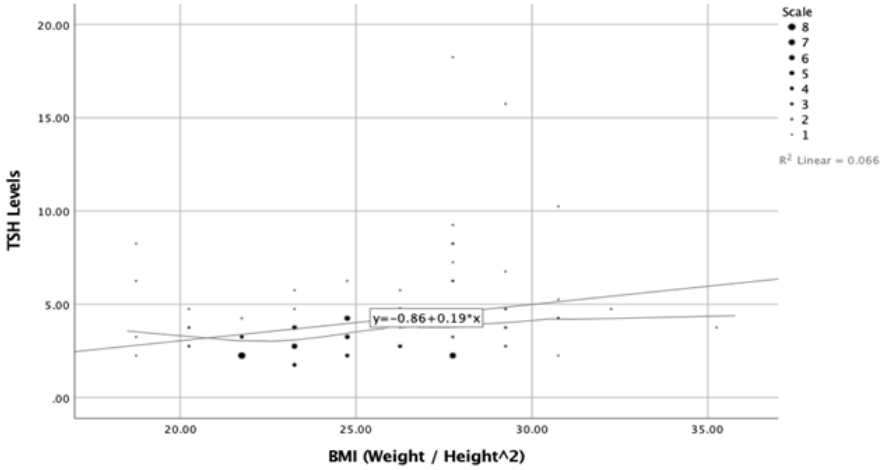


Graph 5: Haemoglobin Percentage

Statistical Analysis: The sample statistics to find the correlation between BMI and TSH, TSH and HbA1C, BMI and HbA1C are done using 2-tailed spearman correlation coefficient. Data is considered to be significant if the $p<0.05$.

Two tailed spearman's correlation between parameters:

1) **BMI vs TSH:** In present study, it was found that TSH has positive correlation with BMI ($r=0.3$, $p=0.002$). The following graph shows the correlation between BMI and TSH.

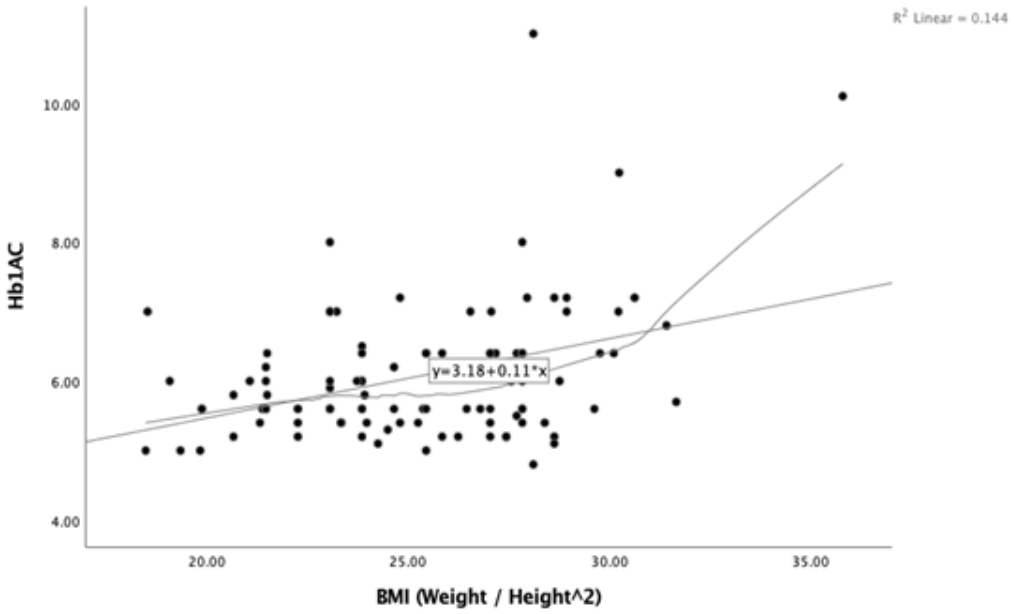


Graph 6: BMI

Table 7:

Column-1	Column-2	Column-3	Column-4	Column-5
Correlations				
			BMI (Weight / Height^2)	TSH Levels
Spearman's rho	BMI (Weight / Height^2)	Correlation Co-efficient	1	0.300 **
		Sig.(2 - tailed)		0.002
		N	100	100
	TSH Levels	Correlation Co-efficient	0.300 **	1
		Sig.(2 - tailed)	0.002	
		N	100	100
** Correlation is significant at the 0.01 level (2- tailed)				

2) BMI vs HbA1c: In the present study, it was found that HbA1C has positive correlation with BMI (r=0.266, p=0.007).

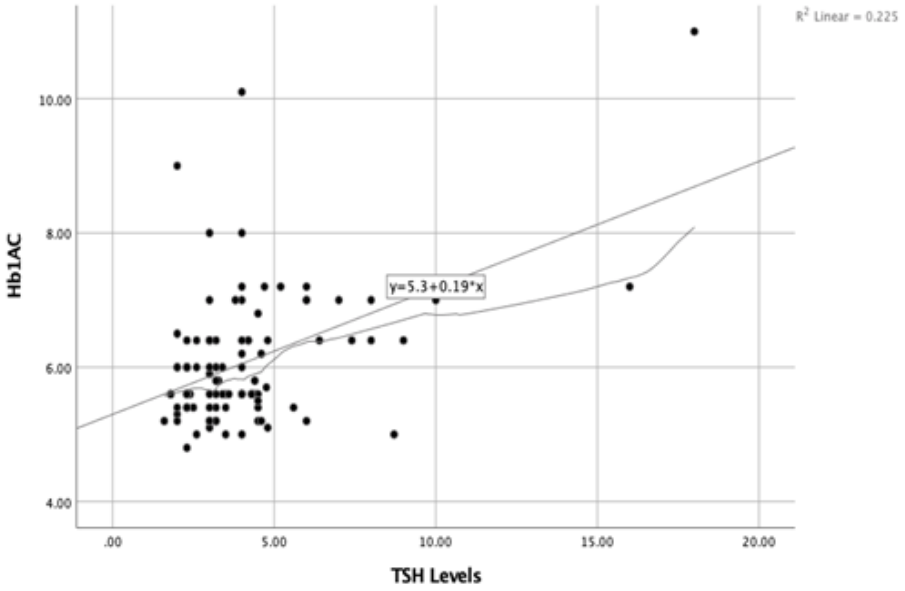


Graph 7: BMI

Table 8:

Column-1	Column-2	Column-3	Column-4	Column-5
Correlations				
			BMI (Weight / Height^2)	HbA1C
Spearman's rho	BMI (Weight / Height^2)	Correlation Co-efficient	1	.266 **
		Sig.(2 - tailed)	.	0.007
		N	100	100
	HbA1C	Correlation Co-efficient	.266 **	1
		Sig.(2 - tailed)	0.007	.
		N	100	100
** Correlation is significant at the 0.01 level (2- tailed)				

3. HbA1c vs TSH : In the present study, it was found that TSH has a positive correlation with HbA1C (r=0.29, p=0.003).



Graph 8: TSH Levels

Table 9:

Column-1	Column-2	Column-3	Column-4	Column-5
Correlations				
			HbA1C	TSH Levels
Spearman's rho	HbA1C	Correlation Co-efficient	1	0.290 **
		Sig.(2 - tailed)		0.003
		N	100	100
	TSH Levels	Correlation Co-efficient	0.290 **	1
		Sig.(2 - tailed)	0.003	
		N	100	100
** Correlation is significant at the 0.01 level (2- tailed)				

Discussion

Polycystic ovary syndrome (PCOS) is a highly prevalent disorder, representing the single most common endocrine-metabolic disorder in reproductive-aged women[10]. Although the pathogenesis of PCOS is not fully understood, it is believed that different factors from epigenetic alterations to obesity, inflammation, and inactivity may aggravate this syndrome.[11]

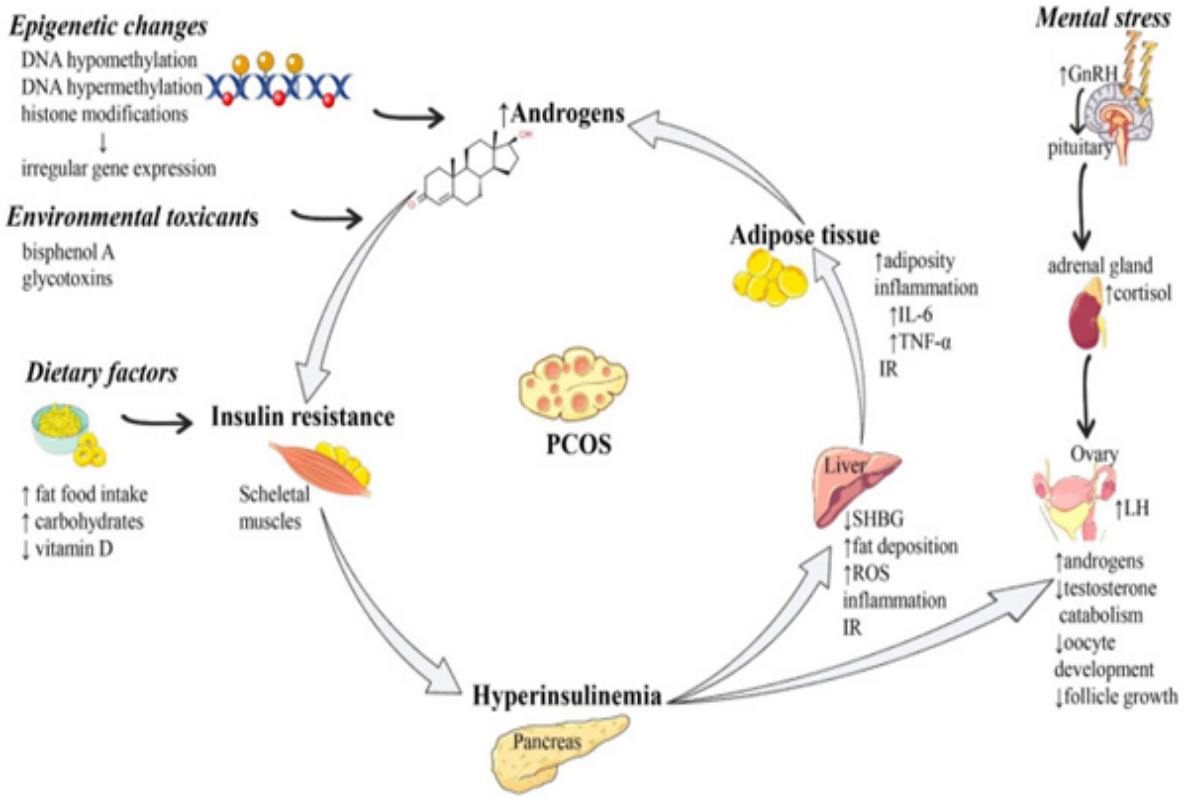


Figure 1:

Summarized scheme regarding the pathophysiology of PCOS. Abbreviations and symbols: ↑ (increased), ↓ (decreased), DNA (deoxyribonucleic acid), GnRH (Gonadotropin-releasing hormone), IL-6 (interleukin 6), IR (insulin resistance), LH (luteinizing hormone), PCOS (polycystic ovary syndrome), SHBG (sex hormone-binding globulin), TNF-α (tumor necrosis alpha).[11] Body mass index (BMI) is the method of utilizing an adult's height and weight to broadly place them into underweight, normal weight, overweight and obese categories. An individual's BMI is important in the determination of potential future health issues and has been widely used as a factor in the determination of various public health policies. The current cut-off points of each category as determined by the World Health Organization (WHO).

Severely Underweight: < 16 kg/m^2

Underweight: 16.0 - 18.4 kg/m^2

Normal weight: 18.5 - 24.9 kg/m^2

Overweight: 25.0 - 29.9 kg/m^2

Moderately Obese: 30.0 - 34.9 kg/m^2

Severely Obese: 35.0 - 39.9 kg/m^2

Morbidly Obese: greater than or equal to 40.0 kg/m^2 [12]

Polycystic ovary syndrome is a genetic condition, exacerbated by obesity. There is a close link between obesity and PCOS based on epidemiological data, and more recently corroborated through genetic studies. weight-gain and obesity contribute towards the development of PCOS. However, there are also mechanisms whereby the development of PCOS can contribute towards further weight-gain and hamper efforts to establish effective weight-loss. In this brief review, we explore the mechanisms whereby weight-gain and obesity contribute towards development of PCOS, and vice versa (summarized in Figure-2). We also explore novel strategies for sustained weight-loss in the management of women with PCOS, and in its prevention.[13]

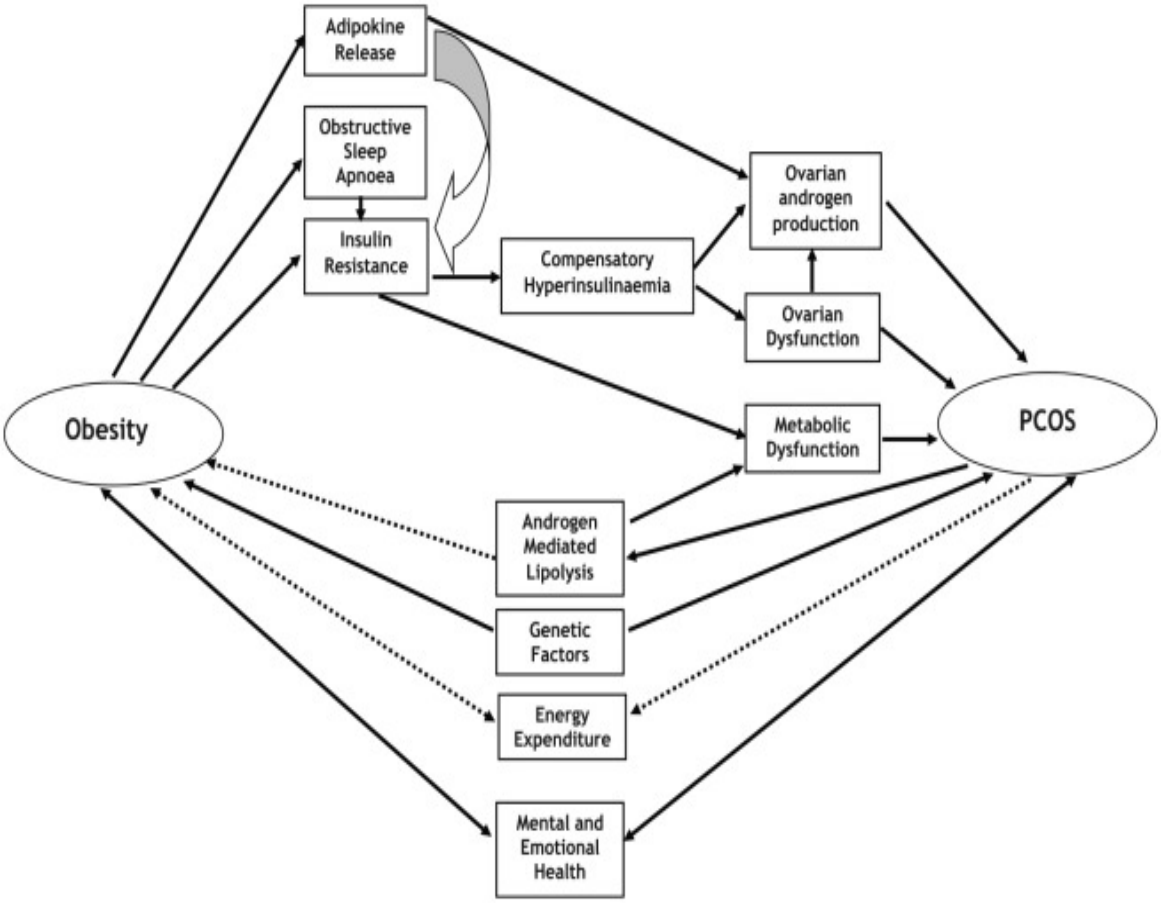


Figure 2:

Summary of mechanisms linking obesity with PCOS. PCOS indicates polycystic ovary syndrome.[13] Thyroid-stimulating hormone, also known as TSH, is a glycoprotein hormone produced by the anterior pituitary. It is the primary stimulus for thyroid hormone production by the thyroid gland.[14] Serum TSH level was significantly higher in PCOS patients than in the control group after adjusting for age and body mass index (BMI).[15] PCOS and thyroid disorders are closely related, and their coexistence may identify patients with a higher reproductive and metabolic risk.[16] Hypothyroid disturbances and elevated TSH levels are common findings in PCOS, which are associated with an adverse metabolic profile. Therefore, women with diagnosed PCOS should be screened for thyroid dysfunction. [17]

The hemoglobin A1c (glycated hemoglobin, glycosylated hemoglobin, HbA1c, or A1c) test is used to evaluate a person's level of glucose control. The test shows an average of the blood sugar level over the past 90 days and represents a percentage. The test can also be used to diagnose diabetes. The amount of glucose that is present in the blood will attach to the hemoglobin protein, and increased glucose levels will reflect on the surface of the hemoglobin protein, thereby rendering a higher A1c level. Hemoglobin A1c (A1C) ≥5.7% is now accepted as a biomarker for identifying individuals at risk for diabetes. Compared to the general population, women with polycystic ovary syndrome (PCOS) have a higher risk for diabetes. [18]

HbA1C detection can be used as a method for diagnosis and screening.[19] The present study conducted on 100 PCOS diagnosed females provides the correlation between BMI, TSH levels and HbA1c. PCOS is known to be associated with weight gain and insulin resistance. In this study maximum percentage of people about 49% have normal BMI. 43% of the study population are overweight. Generally, PCOS females are associated with thyroid dysfunction, 16% of the study population has elevated TSH levels. The correlation between BMI and TSH levels shows the impact of BMI on thyroid functioning, in this present study it was found out that BMI has positive correlation with TSH levels (r=0.3,p=0.002). Patidar B et al. study shows TSH levels have a statistically significant positive correlation with BMI. They concluded that the proportions of thyroid disorders are higher in females with PCOS and they both may present with various similar clinical features. BMI in females with PCOS has significant positive correlation with TSH levels. [8] The correlation between TSH levels and HbA1c provide the effect of thyroid function on metabolism that alters the

HbA1c levels, the present study found that there is a positive correlation between TSH levels and HbA1c levels.

A study conducted by Hiba S. Mahdi also showed a significant positive correlation between HbA1c and TSH. HbA1c level is significantly affected by thyroid dysfunction in PCOS patients as it is higher in the Hypothyroid group and lower in the Hyperthyroid group. [9] The present study also showed a positive correlation between BMI and HbA1c which indicate that PCOS patients with higher BMI might have higher chance to become insulin resistant.

Conclusion

The present study of correlation of BMI, TSH levels and HbA1c among diagnosed PCOS females aimed to find the relation between these factors and their implications to improve the management and treatment strategies for affected individuals. The findings of the present study suggest that there is a positive correlation between these factors i.e, BMI, TSH levels and HbA1c . The main conclusions drawn from this study are,

- There is a positive correlation between BMI and TSH levels (r=0.3,p=0.002)
- There is a positive correlation between BMI and HbA1c (r=0.266,p=0.007)
- There is a positive correlation between TSH levels and HbA1c (r=0.29,p=0.003)

In conclusion this study shows the significant correlation between BMI, TSH levels and HbA1c among diagnosed PCOS females.

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