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Evaluation of Biochemical and Hematological Parameters in Polycystic Ovarian Syndrome Among Urban College Girls

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Abstract: Polycystic Ovarian Syndrome (PCOS) is characterised by increased level of androgens (Male hormones) and decreased level of female hormones causing a set of symptoms in affected females of reproductive age. The present study was aimed to find out the prevalence of PCOS among the urban College girls at Chennai and to analyse the effect of PCOS on hormones, biochemical as well as haematological parameters in the subjects. Out of 1500 urban college girls those who have participated in the survey at Chennai, 147 girls aged between 19-22 were found to have PCOS during the experimental period which was held from July 2019 to March 2020. The percentage of PCOS prevalence among the urban college girls was claimed to be 9.8 % (approximately 10 %). The percentage of obesity, overweight, normal weight and underweight among the urban college girls was arrived by calculating their Body Mass Index (BMI). Out of 1500 urban girl participants, 243 (16.2%) were found to have BMI in between 25 – 29.9 (overweight). It has been observed that 78 girls (5.2%) had BMI more than 29.9 (Obesity). Nearly 117 girls (5.8%) showed BMI lesser than 18.5 (Underweight). Out of 78 obese girls about 40 girls were found to have PCOS (51.28%) and nearly 85 girls had PCOS out of 243 overweight girls (34.97%). The levels of testosterone were found to be increased and progesterone was found to be decreased in test group. High sensitive C reactive protein (HS - CRP) levels showed significant ($p < 0.001$) increase in the PCOS group in comparison with the non PCOS control group. The levels of triglycerides (TG) and cholesterol were found to be increased. The levels of fasting insulin and glucose in the girls with PCOS were found to be significant ($p < 0.001$) in comparison with girls without PCOS. The iron levels in PCOS subjects showed a significantly lower ($p < 0.001$) values in comparison with girls without PCOS. In the current study, PCOS is found to have serious implications on cardiovascular, metabolic and blood parameters. Early diagnosis and treatment of the underlying cause is recommended to the urban college girls with PCOS.

Keywords: Polycystic Ovarian Syndrome, Reproductive hormones, C Reactive protein, lipid profile, Body Mass Index, Biochemical, Hematological

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Introduction

Polycystic ovarian syndrome (PCOS) is a disorder which is characterized by hyperandrogenism and

chronic anovulation in which 6% to 20% of reproductive aged women are affected. During the

early pubertal years, the symptoms of PCOS appears. Irregular menstrual cycles, anovulation, and acne are found in normal female pubertal development as well in PCOS (Witchel *et al.*, 2019). Also, it is accompanied by ovulatory dysfunction, disrupting HPO axis function. (Asunción *et al.*, 2000; Escobar-Morreale *et al.*, 2018)

The complicated pathophysiology of PCOS is due to the complex network of interaction between genetic and epigenetic factors which triggers several hormonal imbalances (Azziz *et al.*, 2004) and related metabolic complications. If untreated PCOS might lead to Obesity, Type II Diabetes mellitus, hypothyroidism, Dyslipidaemia, Coronary heart Disease, hyperinsulinemia, Mood swings, Acne, Pelvic Pain, Dark patches on the skin, hirsutism, androgenic alopecia, Menstrual irregularities like oligo menorrhoea, amenorrhoea, hypermenorrhoea, endometrial hyperplasia, loss of ovulation (anovulation) and difficulty in conceiving.

Dietary modifications and physical exercise have been recommended to manage PCOS. Medications to correct the hormonal imbalances and drugs to improve insulin sensitivity are also prescribed to treat this condition. The present study was aimed to analyse the prevalence of PCOS among the urban College girls at Chennai and to analyse the effect of PCOS on hormones, biochemical as well as haematological parameters in the subjects.

Materials and Methods

Consent was sought from the Head of the Institution and also from the various Heads of the Department of the College to circulate a questionnaire on PCOS to the college girls. The participants were briefed about the significance of this study and the students from the urban parts were selected to fill in the questionnaire. The questionnaire comprised of 43 questions on the following contents:

- 1 Height and Weight of the individual
2. Menstrual manifestation

3. Food habits and physical activity
4. Health condition and mood swings
5. Medications for any ailment

The questionnaire was circulated to 1500 urban girls. Based on the study reports, the following findings were arrived--

- I. Girls with PCOS (confirmed with scan/ test reports)
- II. The prevalence of obese, overweight, normal weight and underweight girls in the college. (Based on their BMI) - Basal Metabolic Index (BMI) - $BMI = m/h^2$ (Mass in kilograms, height in meters)
- III. Obese, overweight, normal weight and underweight girls with PCOS
- IV. PCOS girls with hirsutism, acne, menstrual irregularities and mood swings
- VI Girls who were already undergoing treatment for PCOS
- VI. Girls with PCOS for the past three years without undergoing treatment

A written consent was sought from them for blood collection and the following parameters were analysed with their blood samples. The male and female hormone levels of the group VI girls were estimated and girls with significant increase in their testosterone levels were selected for the study on implications of PCOS. The results were expressed as Mean \pm SD. The level of significance was calculated by student t-test.

Estimation of Reproductive Hormones:

1. Progesterone- Method fully automated chemiluminescence microparticle immunoassay
2. Estradiol/Estrogen (E2) - Method fully automated chemiluminescence microparticle VI particle immunoassay
3. Testosterone - Method fully automated chemiluminescence microparticle immunoassay

Estimation of Cardiac Markers:

High Sensitivity C – reactive Protein(HS - CRP) - Fully automated Latex Agglutination Beckman Coulter

Lipid profile Analysis:

- High Sensitivity C reactive protein (HS - CRP) – Immunoturbidometry – Fully automated latex agglutination – Beckman coulter
- Total Cholesterol – Photometry- CHOD POD Method
- TG – photometry –enzymatic colorimetric method

Estimation of Metabolic Profile:

1. Estimation of Hemoglobin - Drabkins method
2. Estimation of Plasma Glucose – Glucose Oxidase method
3. Insulin – Fasting – Method - Method fully automated chemiluminescence immunoassay
4. Iron – Method – Photometry
5. Total Iron binding Capacity (TIBC) – Photometry

Statistical Analysis:

The mean and standard deviation values of the results were calculated in Microsoft excel and the results were expressed as mean.

Results and Discussion

Prevalence of PCOS in Urban College Girls at Chennai:

Out of 1500 urban college girls those who have participated in the survey at Chennai, 147 girls aged between 19-22 were found to have PCOS during the experimental period which was held from July 2019 to March 2020. The percentage of PCOS prevalence among the urban college girls was claimed to be 9.8 % (approximately 10 %) (Fig. 1). It has been observed from the previous report that the prevalence of PCOS in Chennai city college girls was 6% in 2017 (Bharathi *et al.*, 2017). According to the International studies report the incidence of PCOS ranges in between

4% to 10% among the younger generation. It is quite alarming that the percentage of PCOS prevalence has increased several folds (from 6% to 10%) within a short span of time in urban college girls at Chennai.

Prevalence of obesity, overweight, normal weight and underweight Girls at Chennai:

The percentage of obesity, overweight, normal weight and underweight among the urban college girls (Fig. 2) was arrived by calculating their Body Mass Index (BMI). Out of 1500 urban girl participants 243 (16.2%) were found to have BMI in between 25 – 29.9 (overweight). It has been observed that 78 girls (5.2%) had BMI more than 29.9 (Obesity). Nearly 117 girls (5.8%) showed BMI lesser than 18.5 (Underweight). Maximum number of students 1062 (70.8%) had BMI in between 18.5 – 24.9 which categorise them to have normal weight. The prevalence of obese percentage remains the same, there is a marked increase in the overweight percentage (about 3%) of urban college girls (from 13.2% to 16.2% (Ashok and Karunanidhi., 2016). It has been observed from the survey that their family history, lack of physical activity, altered sleep pattern, stress and intake of high calorie foods were the main reasons for their overweight.

Prevalence of PCOS in obese, overweight, normal weight and underweight College Girls in Chennai:

Out of 78 obese girls about 40 girls were found to have PCOS (51.28%) and nearly 85 girls had PCOS out of 243 overweight girls (34.97%). Out of 1062 normal weight girls 22 had PCOS (2.07%) and out of 117 girls only one girl was found to have PCOS (0.85%) (Fig. 3). The highest percentage of PCOS was noted in obese girls followed by the overweight population in the study group. According to several studies the incidence of PCOS has been shown to be associated closely with obesity and overweight females as this syndrome is closely linked with abnormalities in insulin secretion and sensitivity which are further enhanced by obesity. The genetic predisposition towards the development of PCOS has been shown to be linked strongly with the development of

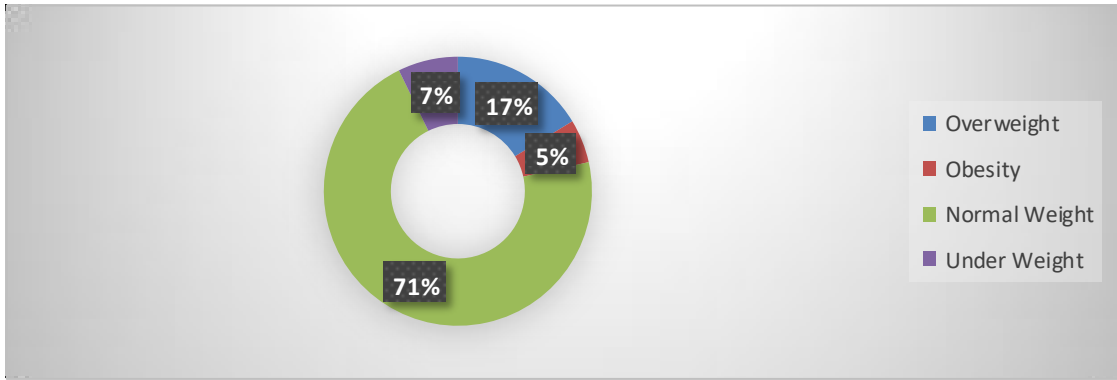
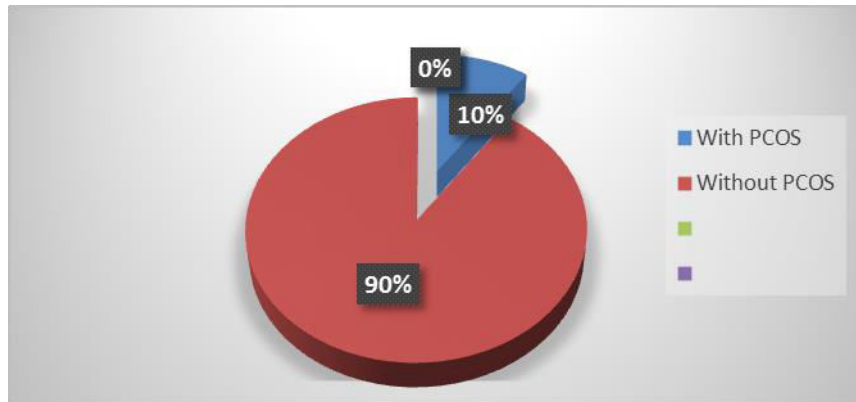


Fig. 1: Percentage of Urban College Girls with PCOS.



Total no of Participants = 1500; No of girls with PCOS = 147

Fig. 2: Percentage of obesity, overweight and Underweight in Urban College Girls.

Body Mass Index (BMI)

Underweight = <18.5
 Normal weight=18.5-24.9
 Overweight = 25-29.9
 Obesity = BMI of 30 or greater

Total Participants: 1500

Overweight = 243
 Obese = 78
 Normal weight = 1062
 Underweight = 117

The percentage of obesity, overweight, normal weight and underweight was calculated by measuring their Body Mass Index (BMI).

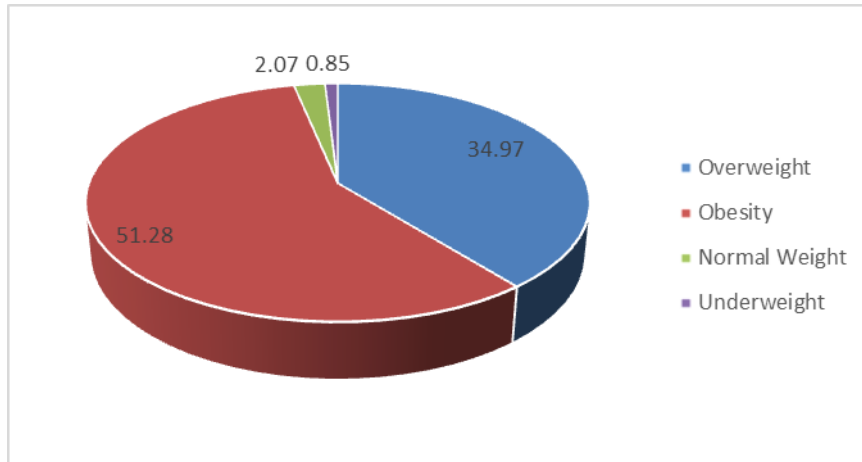


Fig. 3 : Percentage of PCOS in Overweight, Obese, Normal weight and Underweight Urban College Girls.

Total Urban girls with PCOS= 147; Overweight with PCOS = 85; Obese with PCOS= 40; Normal weight with PCOS = 22; Underweight with PCOS = 1

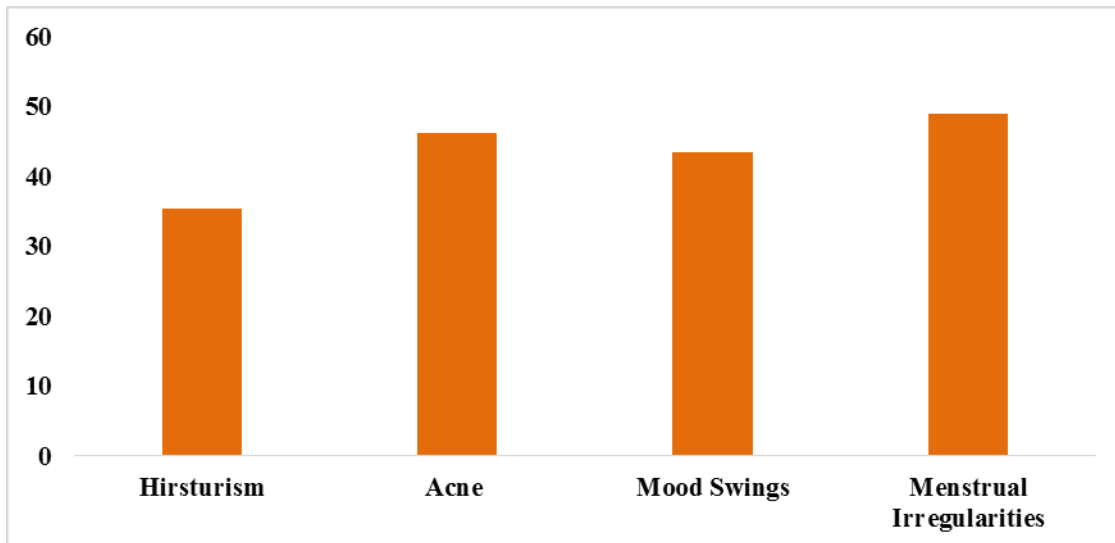


Fig. 4: Percentage of PCOS Girls with Hirsutism, Acne, Mood Swings and Menstrual Irregularities.

Total number of girls with PCOS = 147; Girls with Hirsutism = 52; Girls with Acne = 68; Girls having Mood swings = 64; Girls with Menstrual Irregularities = 72

various clinical conditions and implications pertaining to their hormonal imbalance has been reported by several analysis (Balen *et al.*, 1995; Legro, 2000; Barber *et al.*, 2006)

Prevalence of Acne, Mood swings, Menstrual Irregularities and Hirsutism in Urban girls with PCOS:

Out of 147 urban girls with PCOS, 64 girls had severe acne issues (68%), nearly 64 students had

mood swings (43.5%), 72 students had menstrual irregularities (48.9%) and 52 students had Hirsutism (35.3%) (Fig. 4). The percentage of cutaneous manifestations like acne and hirsutism vary widely based on their androgen level, dietary habits and cosmetic care. A previous study report revealed that acne contributed lowest among the cutaneous issues in adolescents with PCOS (Vexiau *et al.*, 1990; Timpatanapong *et al.*, 1997; Borgia *et al.*, 2004).

In contrast, the percentage of girls having acne issues were higher than that of the percentage of girls having hirsutism. The reports on hirsutism also stated that nearly 50 % - 80 % of PCOS affected girls showed facial hair and also hair growth on various androgenic areas of their body (Rotterdam ESHRE/ ASRM-Sponsored PCOS Consensus Workshop Group, 2004; Yildiz, 2006) but in the present study only 35.3% of the girls showed hirsutism.

Around 43.4% college girls reported to have mood disorders like irritability, anxiety, anger and depression. The etiological background is still obscure. Less understanding exists between the psychological and biological variables for polycystic ovary syndrome. More focus is to be emphasised to understand the relationship between the psychological changes experienced by the women with PCOS and her biochemical parameters including the altered steroid hormone levels. The levels of DHEAS (Deandroepiandrosterone) level play a significant role in the etiopathogenesis of PCOS. Reports indicate that steroid hormones (DHEAS) synthesized by zona reticularis of the adrenal cortex cause some mood disturbance and gastrointestinal symptoms (Bovenberg *et al.*, 2005; Rainey and Nakamura, 2008). The increased risk of psychological behavioural changes may be also due to the chronic hormone conditions and should be cope up by the individual through correction of hormone imbalance, counselling, and adequate

intervention (Himelein and Thatcher, 2006; Jones *et al.*, 2008; Dokras *et al.*, 2011).

Among the urban girls with PCOS, 48.9 % of them found to have menstrual irregularities like heavy/ low menstrual flow and irregular cycle. It is observed that menstrual issues arise before the onset of PCOS in several cases (Pinola *et al.*, 2012; Bouzas *et al.*, 2014). The severity of the menstrual disturbances were directly proportional to the intensity of the endocrine abnormalities which in turn reflects on the metabolic consequences associated with it (Dunaif *et al.*, 2001; Xu *et al.*, 2009; Xu *et al.*, 2012). The results of Strowitzki *et al.* (2010) suggests that PCOS with obesity enhances the chances of menstrual irregularities whereas girls with regular menstrual cycle (normocyclic) with normal weights claimed to have lesser metabolic consequences than the obese PCOS female with irregular menstrual cycle. Women with PCOS usually have an ovulatory cycle with abnormal uterine bleeding which predisposes to endometrial hyperplasia and carcinoma if not treated. Hence, women with menstrual abnormalities are advised to take necessary corrective measures in order to be protected from development of the severe ailments associated with it.

Estimation of Male and Female Reproductive hormone levels in Urban College Girls:

Table 1 depicts the levels of Hormones of young women without PCOS (control) and young women with PCOS. The testosterone levels of the test

Table 1: Estimation of Hormonal level of young women without PCOS (control) and young women with PCOS (TEST)

S. No.	PARAMETER	CONTROL	TEST
1.	Estradiol/Oestrogen pg/ml	34.8 ± 1.72	35.22 ± 1.33 ^{ns}
2.	Testosterone pg/ml	0.93 ±0.67	1.98 ±0.79*
3.	Progesterone ng/ml	16.4 ± 1.08	13.7 ± 1.56**

Values are expressed as mean ± S.D.; N = 30; ns- P >0.05; * P≤0.01; ** P≤0.001

Table 2: Levels of CRP in young women with PCOS

S. No.	Parameter	Control	Test
1.	CRP	2.35 ± 0.27	4.27 ± 0.26*

Values are expressed as mean ±S.D; N = 30; *P<0.001

group showed a significant increase (P<0.05) in comparison with the control group. The results of oestrogen were found to be non-significant as compared to the control group. The levels of testosterone were found to be increased and progesterone was found to be decreased in test group. According to the new 2006 regulations called Androgen Excess and PCOS Society (AE-PCOS, formerly the Androgen Excess Society) the hyperandrogenism and ovarian dysfunction were found to be the authenticated symptoms for PCOS.

Excess androgen levels are the fundamental factor in the pathogenesis of PCOS. Increase in testosterone levels are strongly associated with obesity, in particular with an abdominal fat distribution as well as with IR and a higher prevalence of glucose intolerance. Due to the highly variable heterogenous symptoms of PCOS the study group girls were selected on the basis of hyperandrogenism with menstrual abnormalities. As PCOS has been shown to be associated with various metabolic and other complications, girls having PCOS for the past three years were selected for the implication study on their cardiac, liver, kidney, metabolic, thyroid and complete blood parameters.

Implications of PCOS on Heart:

Table 2 depicts the levels of CRP in young women with PCOS. The levels of High sensitive C reactive protein (HS - CRP) levels showed significant (p<0.001) increase in the PCOS group in comparison with the non PCOS control group. CRP levels are elevated in patients with PCOS and may be a marker of early cardiovascular risk in these patients. CRP levels are elevated in patients with PCOS and may be a marker of early cardiovascular risk in these patients. High CRP levels may explain

why some PCOS women may possibly be at an increased risk for the development of early-onset CVD. (Boulman *et al.*, 2004; Kamath *et al.*, 2015).

Lipid Profile:

Table 3 depicts the level of lipid profile in young women with PCOS. The levels of triglycerides (TG) and Lipoprotein A also showed a significant increase (p<0.001). As HS - CRP has been associated with inflammation, increased levels of HS- CRP along with elevated levels of leucocytes claims a low-grade chronic inflammation in PCOS. Elevated HS – CRP along with enhanced levels of inflammatory cytokines (such as interleukin-6 and interleukin-18) and raised total cholesterol to LDL ratio were the aggravating factors for cardiovascular complications.

Dyslipidemia associated with insulin resistance is a most common abnormality in women with polycystic ovary syndrome (PCOS). Individuals with dyslipidemia along with PCOS are more susceptible to insulin resistance. Studies on inflammatory markers in PCOS also show that there was a positive correlation between Insulin resistance. WBC, BMI and CRP (Tarkun *et al.*, 2004; Orio *et al.*, 2005; Papalou *et al.*, 2015). The proinflammatory state was showcased by 2-fold elevated levels of CRP in PCOS women (Escobar-Morreale *et al.*, 2011) Women with PCOS were found to be dyslipidaemic with increased triglyceride levels, reduced HDL cholesterol and altered lipoprotein A levels (Kim *et al.*, 2013).

The data obtained in the current study indicated that there is a greater risk of cardio-

Table 3: Level of lipid profile in Young women with PCOS

S. No.	Parameters (mg/dl)	Control	Test
1	Total Cholesterol	166.5±6.64	214.09±12.27*
2	Triglycerides	153.75±7.56	208.9±6.04**
3	LDL	125.7±5.58	161.5±5.71*
5	HDL	54.83 ± 7.35	38.12 ± 5.20*

Values are expressed as mean ±S.D; N = 30; *P<0.05; **P<0.001

Table 4: Level of metabolic profile among young women with PCOS

S. No.	Parameters	Control	Test
1	Iron (µm/l)	70.39± 3.51	41.7 ± 2.65 ^{ns}
2	Total Iron Binding Capacity (µg/dl)	446.7± 15.07	499.3±15.79*
3	Hemoglobin (g/dl)	12.8 ± 0.40	7.2 ± 0.32***
3	Insulin -Fasting (mIU/l)	17.30±0.88	21.33±1.78
4.	Plasma Glucose (mg/dl)	81.21±8.20	89.02 ± 9.44**

Values are expressed as mean ±S.D; N = 30; ns- P >0.05; *P<0.05; **P<0.01; ***P<0.001

vascular/atherogenic index in the PCOS girls which might be associated with insulin resistance and obesity. The PCOS variables including the altered hormonal levels might have resulted in the reciprocal relationship between HDL -C and triglycerides. These changes may contribute to the development of cardiovascular abnormalities (Tsompanidi *et al.*, 2010).

Implications on Metabolic profile:

Table 4 depicts the Level of metabolic profile among young women with PCOS. The levels of fasting insulin and glucose in the girls with PCOS were found to be highly significant (p<0.001) in comparison with girls without PCOS. The levels of haemoglobin were found to be lowered in PCOS group. Most of the women with PCOS have encountered Insulin resistance which may be due to the compensatory hyperinsulinemia. Reports indicate that insulin

resistance (IR) as the primary link associating these conditions (Toprak *et al.*, 2001; Reaven *et al.*, 2011). Elevated levels of insulin could end up in the risk of gestational diabetes mellitus in PCOS women (Polson *et al.*, 1988; Knochenhaur *et al.*, 1998)

The iron levels in PCOS subjects showed a significantly lower (p<0.001) values in comparison with girls without PCOS. The total iron binding capacity were found to be non-significant. The deficiency of Iron might be due to the heavy periods in PCOS girls and if this condition prevails it might cause iron deficient anaemia which is quite common in adolescent PCOS girls. A balanced diet with rich iron content was recommended to combat this issue. In contrast, studies have reported that insulin resistance and hyperandrogenism leads to increased iron absorption and iron overload in

obese PCOS patients with oligo menorrhoea or amenorrhoea. In order to address this issue a detailed correlation study on the iron metabolism and altered hormone levels in PCOS women is required (Shekhar, 2005; Alvarez-Blasco *et al.*, 2006).

Conclusion

In recent years there is an alarming increase in the development of the lifestyle disorders like type 2 Diabetes mellitus, hypertension, obesity, coronary heart diseases and endocrine abnormalities among younger generation. At the same time the infertility rate of urban community in India is also found to be on enormous escalation and it has been observed from the previous studies that one of the main reasons for the female infertility is PCOS in women during their prime reproductive age. It has been observed from the survey that the family history, lack of physical activity, stress and having high calorie foods were the main reasons for their increased weight. The incidence of PCOS has been shown to be associated closely with obesity and overweight females as this syndrome is closely linked with abnormalities in insulin secretion and sensitivity which are further enhanced by obesity. The women with cosmetic issues, psychological issues and menstrual abnormalities are advised to take necessary corrective measures in order to be protected from severe ailments associated with it. As dyslipidaemia and elevated CRP levels were strongly associated with the risk of cardiovascular abnormalities, proper physical activity and management of low-grade inflammation with proper diet and medications on physician advice are recommended. In order to overcome iron deficiency, foods rich in iron and iron supplements on physicians' advice are recommended. In the current findings PCOS is found to have serious implications on cardiovascular, metabolic and blood parameters. Early diagnosis and treatment of the underlying cause is recommended to the urban college girls with PCOS.

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