Correlation of Perceived Stress with Waist-Hip Ratio, Lipid Profile, and Fasting Sugar in Newly Diagnosed Patients with Polycystic Ovarian Syndrome in an Urban Population of West Bengal

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**Background:** Higher prevalence of stress in polycystic ovarian syndrome (PCOS) patients may have a critical role in their altered body composition. **Aims:** The aim is to study the correlation of perceived stress with waist-hip ratio (WHR), lipid profile, and fasting sugar in newly diagnosed patients with polycystic ovarian syndrome in an urban population of West Bengal. **Materials and Methods:** This cross-sectional pilot project was conducted in the Department of Physiology, Burdwan Medical College, in a time span of 1 year after taking institutional ethical clearance and informed consent of the participants. One hundred newly diagnosed PCOS patients and 100 age-, dietary habit-, and body mass index (BMI)-matched controls were included in the study. The Perceived Stress Scale (PSS) scores of the participants were assessed. Fasting blood samples were drawn from participants for analysis of fasting blood sugar (FBS) and lipid profile. Height, weight, BMI, WHR, resting pulse rate (measured after 15 min of rest with participants in supine posture), and blood pressure (measured by mercury manometer) were measured. The computer software “Statistical Package for the Social Sciences (SPSS) version 16” was used to analyze the data, and unpaired t-test was used to compare different parameters of the two groups. Correlation of PSS with other parameters was assessed. **Results:** There was a significant difference in PSS, WHR, pulse, blood pressure, FBS, and lipid profile between the two groups. There was a significant positive correlation between PSS and WHR, FBS, and lipid profile, and high-density lipoprotein cholesterol was negatively correlated with PSS. However, no difference in BMI was observed. **Conclusion:** PCOS patients with higher PSS in spite of having equivalent BMI, dietary habits, and age may have higher WHR, dyslipidemia, and fasting sugar as compared to normal individuals. Stress management programs are need of the day for the highly stressed modernized global population. **Keywords:** Metabolism, perceived stress, polycystic ovarian syndrome

**INTRODUCTION**

Our overindustrialized and highly competitive metropolitan culture has added up to our stresses at different levels. Stress experiences often lead to various chronic health conditions such as hypertension, coronary heart disease (CHD), and metabolic syndrome (MBS).[1-4] Women have major roles to play in the collective social well-being. Stress may lead to early aging and death or sometimes in reduced levels of performances in females. Recent researches have proved that most women (across cultures and borders) are too much stressed. As has been proved, 25% of females in the United States die of heart diseases,[1-3] whereas 87% of Indian women feel stressed most of the times, with 82% having insufficient time to

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Polycystic ovarian syndrome (PCOS) is one of the most common endocrinopathies, affecting 6.5% and 8% of women. The syndrome is characterized by oligomenorrhea and hyperandrogenism and the presence of associated risk factors for cardiovascular disease (CVD), including obesity, glucose intolerance, and dyslipidemia. PCOS may be associated with mood disorders and eating disorders. Women with PCOS are a specific group of women who have several aspects of MBS. Concomitantly, MBS could be part of metabolic abnormalities present in PCOS. Stress has been linked to aggravate the metabolic abnormalities present in MBS. The altered stress reactivity in PCOS patients may constitute a link between depression, overweight, and cardiovascular risks.

Stress is an invisible factor affecting modern-day living and is strongly associated with many disease pathogenesis including polycystic ovarian syndrome (PCOS) in women. PCOS is the most frequent endocrinological disorder that affects women of reproductive age, leading to metabolic dysfunction and body composition alterations. Salivary amylase and cortisol are major stress mediators that have been implicated in PCOS. A study in 2018 was conducted to understand the relation between stress-associated factors and alterations in body composition among PCOS patients. This study included a total of 100 patients (PCOS) and 60 age-matched controls in the age group of 13 and 30 years. Standard assay kits were used to evaluate the α-amylase activity and cortisol level in saliva.

Increased salivary cortisol level and α-amylase activity were seen in the PCOS population as compared to age-matched controls suggesting patients a sustained stress scenario in their system. Moreover, overweight PCOS participants reflected higher amylase activity than the lean participants. Pulse rate, body mass index (BMI), visceral adiposity, and waist-hip ratio (WHR) were considerably higher in the PCOS participants compared to controls. A significant correlation could be drawn between the α-amylase activity and BMI or WHR, respectively, among PCOS patients.

Polycystic ovarian syndrome (PCOS) is associated with increased psychological distress. Damone et al. in 2018 studied depression, anxiety, and perceived stress in women with and without PCOS in a large community-based sample and investigated the role of stress in contributing to and mediating the relationship between PCOS, depression, and anxiety.

A cross-sectional analysis was performed from the Australian Longitudinal Study on Women’s Health comparing women with \( n = 478 \) or without \( n = 8134 \) a self-reported diagnosis of PCOS. Main outcome measures were depression, anxiety, and perceived stress measured using validated scales. Women reporting PCOS, compared with women not reporting PCOS, reported a higher prevalence of depression, anxiety symptoms, and greater score for perceived stress. After adjusting for BMI, infertility, and sociodemographic factors, women with PCOS were found to be still more likely to be depressed and anxious and to have a higher level of perceived stress.

The highest coronary mortality at present is seen in European region followed by Southeast Asia region, and India being a part of this region also faces the challenge of coronary mortality. There has been considerable increase in the prevalence of CHD in urban areas in India in the last decade.

Urban populations as compared to their rural counterparts are at higher risk of developing CHD, and prevalence rate per 1000 for CHD is higher in females as compared to males in the age group of 25–54 years. There are various risk factors for the development of CHD. Some are modifiable (cigarette smoking, high blood pressure, elevated serum cholesterol, diabetes, obesity, sedentary habits, and stress) and others are nonmodifiable (age, sex, family history, and genetic factors). Stress is a modifiable risk factor for the development of CHD.

It is in the above context that the present study aimed to observe the correlation of perceived stress with WHR, lipid profile, and fasting sugar in newly diagnosed patients with polycystic ovarian syndrome in an urban population of West Bengal.

**Materials and Methods**

This cross-sectional pilot project was conducted in the Department of Physiology, Burdwan Medical College, in a time span of 1 year after taking institutional ethical clearance from Institutional Review Board of Burdwan Medical College (BMC 2716 dated 15-11-2016), and informed consent of the participants.

**Inclusion criteria**

One hundred healthy young adult Indian females in the age group of 20–30 years newly diagnosed as having PCOS were selected as study population and 100 age- and sex-matched participants from local population not performing were selected as control.

Patients in the age group of 20–30 years (24.65 ± 2.81) with newly diagnosed polycystic ovarian disease visiting
gynecology outdoor of the hospital were included in the study. PCOS was diagnosed according to the Rotterdam criteria, i.e., oligomenorrhea/amenorrhea, clinical or biochemical signs of hyperandrogenism, and polycystic ovaries on ultrasound.

**Sampling method**

Sampling of PCOS patients and normal participants was done using an online randomizer.

**Exclusion criteria**

Participants suffering from chronic debilitating diseases such as CHD, hypertension, diabetes mellitus, nephropathy, respiratory diseases, neuropathy, bleeding disorders, malignancy smokers, and alcoholics, persons receiving any drugs that may affect the autonomic reflexes, and participants on any daily exercise regimen other than Yoga were excluded.

The sample size was calculated with Epi Info 6 software (Centers for Disease Control and Prevention (CDC), Atlanta, Georgia, US) with \( \alpha = 0.05 \) and \( \beta = 0.2 \) considering previous studies.\(^{[16]} \)

On the first appointment, history was carefully recorded followed by clinical examination, and perceived stress of the participants was measured using the Perceived Stress Scale (PSS).\(^{[17]} \)

Randomization was done using an online randomizer. All participants were on nonvegetarian diet and their dietary habits were nearly similar. Age and dietary habits on the 1st day of examination were recorded, and there was no significant difference in both parameters with the control group in our study with \( P > 0.05 \).

The PSS of Sheldon Cohen, the most widely used psychological instrument for measuring the perception of stress, was used. It is a measure of the degree to which situations in one’s life are appraised to be stressful. The questions in the PSS ask about feelings and thoughts during the last month. It comprises ten items, four of which are reverse scored, measured on a five-point scale from 0 to 4. PSS scores are obtained by reversing responses (e.g., 0 = 4, 1 = 3, 2 = 2, 3 = 1, and 4 = 0) to the four positively stated items (items 4, 5, 7, and 8) and then summing across all scale items. Total score ranges from 0 to 40.\(^{[12]} \)

Pretest instructions were given to avoid consumption of any drug that may alter the cardiorespiratory parameters 48 h prior to the test. The participants were advised to have light dinner within 08 pm and go to bed early and avoid stressful situations during the day before the tests were conducted. Relaxing bedtime routine, such as soaking in a hot bath or hot tub and then reading a book or listening to soothing music, was advised. They were asked to avoid caffeine (e.g., coffee, tea, soft drinks, and chocolate), nicotine (e.g., cigarettes and tobacco products), and alcohol close to bedtime. On the day of the test, no cigarette, nicotine, coffee, or drugs were permitted. Informed consent was obtained from the participants. All these protocols were used as an additional precautionary measure to decrease perceived stress in participants which may alter test results in spite of the recruitment of participants following exclusion criteria.

Fasting blood samples were drawn from participants for analysis of fasting blood sugar (FBS) and lipid profile. Anthropometric measurements (height, weight, BMI, and WHR), resting pulse rate (measured after 15 min of rest with participants in supine posture), and blood pressure (measured by mercury manometer) were recorded. The participants were made to rest for 15 min in supine position. The resting time given to participants in between two tests was 5 to 10 min. All the tests were done in postmenstrual phase 5–10 days of menstrual cycle to exclude stress effects of premenstrual period.

The computer software “Statistical Package for the Social Sciences (SPSS) version 16 (SPSS Inc., Released 2007. SPSS for Windows, version 16.0. SPSS Inc., Chicago, Illinois, USA)” was used to analyze the data, and unpaired \( t \)-test was used. Correlation coefficient was calculated to study the correlation of PSS with other parameters. The data were considered significant and highly significant if the analyzed probability values (\( P < 0.05^* \) and \( P < 0.01^{**} \), respectively). Spearman correlation was used to study correlation since PSS is ordinal data.

**Results**

This cross-sectional project was carried in a time span of 1 year on 100 newly diagnosed PCOS patients and 100 age-, dietary habit-, and BMI-matched controls. Unpaired \( t \)-test was used to compare different parameters of the two groups. There was a significant difference in PSS, WHR, pulse, blood pressure, FBS, and lipid profile between the two groups [Tables 1-4 and Figures 1 and 2].

| Parameters | Participants with PCOS | Normal participants | \( P \) |
|------------|------------------------|---------------------|---|
| Age (years) | 26.61±5.21             | 26.16±5.25          | 0.549 |
| BMI (kg/m²) | 22.91±3.98             | 22.16±3.64          | 0.16 |
| Waist-hip ratio | 0.83±0.05 | 0.819±0.04        | 0.03^* |

Results showed no significant difference in age and BMI between two groups, but significant difference was observed in waist-hip ratio. \( ^*P<0.05 \) (significant), SD: Standard deviation, BMI: Body mass index, PCOS: Polycystic ovarian syndrome
There was a significant positive correlation between PSS and WHR, FBS, and lipid profile, and high-density lipoprotein cholesterol (HDL-C) was negatively correlated with PSS [Table 5].

**DISCUSSION**

Women have a life-expectancy advantage over men but a marked disadvantage with regard to morbidity. Individual differences in physical and mental health are further notably explained by the degree of stress individuals endure, with women being more affected by stressors than men. Female participants in reproductive age group in the present study were included because of a specific reason. As has been already stated, most Indian women are overstressed. In a survey conducted in 2011, it was found that the highest stress is perceived by women between 25 and 55 years who have to manage multiple roles in various fields. It is seen that the average life span of Indian women is 65 years, while in developed countries, it is 80 years. Hence, women of our country specifically of this age group deserve special attention.

The present cross-sectional project was carried in a time span of 1 year on 100 newly diagnosed PCOS patients and 100 age-, dietary habit-, and BMI-matched controls. Unpaired t-test was used to compare different parameters of the two groups. There was a significant difference in PSS, WHR, pulse, blood pressure, FBS, and lipid profile between the two groups. There was a significant positive correlation between PSS and WHR, FBS, and lipid profile, and HDL-C was negatively correlated with PSS.

The altered stress reactivity in polycystic ovarian syndrome (PCOS) may constitute a link between depression, overweight, and cardiovascular risk factors. Stress is thought to influence human eating behavior. Stress appears to alter overall food intake in two ways, resulting in under or overeating. Chronic life stress seems to be associated with a greater preference for energy and nutrient-dense foods. Stress-induced eating may be one factor contributing to the development of obesity which increases the risk

| Parameters | Mean±SD | P |
|------------|---------|---|
| Pulse (beats per minute) | 74.7±4.53 | 72.7±3.02 | 0.0003** |
| SBP (mmHg) | 117.7±7.88 | 113.9±5.9 | 0.00021** |
| DBP (mmHg) | 78.04±6.46 | 75.36±5.4 | 0.0002** |

Results show significant difference in pulse, SBP, and DBP between these two groups. **P<0.01 (highly significant). SD: Standard deviation, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, PCOS: Polycystic ovarian syndrome
of CVDs.\textsuperscript{19–23} Several etiological factors for obesity have been identified, whereas other factors related to obesity, such as stress, remain poorly understood. Stress has been associated with obesity, chronic diseases, and psychosocial factors. Studies on psychological stress have focused on stress-related psychopathologies. In a study in 2017,\textsuperscript{22} psychiatric interviews and surveys of coping mechanisms were used to identify stressful events among individuals with obesity. One finding of this study was that stress was more prevalent in a group of severely obese individuals than in a control group.

The distribution of body fat in different positions of our body has a significant effect in various health issues, mainly the central obesity, i.e., abdominal subcutaneous fat is strongly responsible for morbidity than subcutaneous fat in any other site of our body.\textsuperscript{23} Evidence from longitudinal studies suggests that chronic life stress may be causally linked to weight gain. Stress-induced overeating may be one reason contributing to the development of obesity which increases the risk of CVD. A study in 2014\textsuperscript{22} showed that, compared with nonstress-driven eaters, stress-driven eaters had a higher prevalence of overweight, obesity, and abdominal obesity.\textsuperscript{22} The present study also showed significantly higher values of WHR in participants with PCOS, compared to normal participants, though there was no significant difference in BMI between the two groups and WHR was positively correlated with perceived stress levels. Studies have also shown that body fat distribution is a major factor, particularly visceral fat carrying the greatest risk for cardiovascular morbidity and mortality.\textsuperscript{24–26}

In the present study, FBS was significantly more in group with higher stress level, and PSS scores were positively correlated with FBS. A study in 2017\textsuperscript{27} examined the temporal relationship between perceived stress and type 2 diabetes in a middle-aged cohort of Australian women over 12 years. Women born between 1946 and 1951 (n = 12,844) completed these surveys for the Australian Longitudinal Study on Women’s Health in 1998, 2001, 2004, 2007, and 2010. The total causal effect was estimated using logistic regression and marginal structural modeling. Controlled direct effects were estimated through conditioning in the regression model. A graded association was found between perceived stress and all mediators in the multivariate time-lag analyses. A significant association was found between hypertension, as well as physical activity and BMI, and diabetes. No association was found with smoking or diet quality. Moderate/high-stress levels were associated with a 2.3-fold increase in the odds of diabetes 3 years later, for the total estimated effect. Results were only slightly attenuated when the direct and indirect effects of perceived stress on diabetes were partitioned, with the mediators only explaining 10%–20% of the excess variations in diabetes.

Perceived stress has been found to be a strong risk factor for type 2 diabetes. The majority of the effect estimates of stress on diabetes risk are not mediated by the traditional risk factors of hypertension, physical activity, smoking, diet quality, and BMI. This gives a new pathway for diabetes prevention trials and clinical management.\textsuperscript{28,29} A study conducted in 2013\textsuperscript{28} showed that adiposity had little influence on the relationship between stress and abnormal glucose metabolism. Likewise, another study\textsuperscript{29} found that obesity did not predict progression to diabetes from impaired fasting glucose and/or impaired glucose tolerance in Japanese workers.

Stress is a known factor responsible for the development of dyslipidemia, and dyslipidemia is known to alter autonomic functions by decreasing heart rate variability and baroreceptor sensitivity.\textsuperscript{30–33}

Previous studies have suggested that mental status may influence serum lipid levels. A study\textsuperscript{33} was conducted on the adult population living in rural and urban areas in Central Iran to assess the correlation between stress level and lipid profile disorders. The study population consisted of 9752 adults aged ≥19 years living in three districts, namely Isfahan, Arak, and Najafabad. Demographic data, age, and sex were recorded. Blood samples were taken to determine the lipid levels, i.e., total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), low levels of HDL-C, and triglycerides (TGs). Stress levels were assessed using the General Health Questionnaire. Logistic regression and Chi-square tests were used for statistical analysis. The odds ratios of high stressed

### Table 5: Correlation of different parameters with Perceived Stress Scale

| Parameters          | Correlation with PSS, R | Participants with PCOS | Normal participants |
|---------------------|-------------------------|------------------------|---------------------|
| FBS (mg/dL)         | 0.52                    | 0.41                   | 0.03*               |
| Cholesterol (mg/dL) | 0.58                    | 0.19                   | <0.0001**           |
| Triglyceride (mg/dL)| 0.49                    | 0.39                   | 0.001**             |
| LDL (mg/dL)         | 0.36                    | 0.27                   | <0.0001**           |
| HDL (mg/dL)         | 0.58                    | 0.183                  | <0.0001**           |
| VLDL (mg/dL)        | −0.4                    | −0.03                  | <0.0001**           |
| Waist-hip ratio     | 0.43                    | 0.24                   | <0.0001**           |

Results show significant positive correlation of PSS with lipid profile, FBS, and negative correlation with HDL. *P<0.05 (significant), **P<0.01 (highly significant), r: correlation psychopath. FBS: Fasting blood sugar, LDL: Low-density lipoprotein, HDL: High-density lipoprotein, VLDL: Very LDL, SD: Standard deviation, PCOS: Polycystic ovarian syndrome, PSS: Perceived Stress Scale
individuals had high levels of TC and LDL-C as compared to normal individuals and low levels of HDL-C compared to normal individuals after adjustment for age and sex. Similar results were also observed in the present study. No significant correlation was found between stress levels and TG in the above study. Thus, stress produces significant cardiovascular hazards by altering biochemical parameters. From the findings of the present study, it is observed that PCOS patients with higher PSS in spite of having equivalent BMI, dietary habits, and age had higher WHR, dyslipidemia, and fasting sugar as compared to normal individuals and PSS may be considered as a significant contributor in the development of PCOS.

This was a cross-sectional study, and we had conducted a longitudinal study in 2014\(^6\) to observe the effects of progressive muscle relaxation (PMR) in PCOS patients. The stress levels were assessed, and conventional autonomic function tests and the lipid profiles were analyzed. The participants were divided into two groups using an online randomizer. One group received medication, whereas the other group received medication and practiced PMR for 3 months. All parameters were re-evaluated at the end of 3 months. The PSS was significantly less in participants practicing relaxation exercises, as compared to participants only on medication. The WHR, pulse rate, and systolic blood pressure were significantly lower, while there was no difference in the BMI and diastolic blood pressure. Results of the autonomic function tests showed a significant parasympathetic tilt in participants practicing PMR. In patients with PCOS, who were on PMR, cholesterol, TGs, and LDL-C were significantly lower and HDL-C was significantly higher.

Limitations
This is a cross-sectional study so whether PSS may be considered as a significant contributor in the development of PCOS cannot be concluded, longitudinal studies with longer follow-up intervals are required for future studies.

Conclusions
PCOS patients with higher PSS in spite of having equivalent BMI, dietary habits, and age may have higher WHR, dyslipidemia, and fasting sugar as compared to normal individuals. Stress management programs are need of the day for the highly stressed modernized global population.

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Conflicts of interest
There are no conflicts of interest.

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