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Original Article

Correlation of Heart Rate Recovery with Cardiorespiratory Fitness in Polycystic Ovary Syndrome with Hypothyroid Patients

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ABSTRACT

Background and Aim: Poly cystic ovarian syndrome and thyroid disorders are the commonest endocrine disorders. Hypothyroid can lead to polycystic morphology of the ovaries and is therefore commonest finding in PCOS patients. Disturbances of the autonomic nervous system play a crucial role in the pathogenesis and clinical course of many diseases. Cardiorespiratory Fitness (CRF) is an objective measure of habitual physical activity and also a useful diagnostic and prognostic health indicator for patients in clinical settings. Many studies have suggested that CRF has an impact on the autonomic control of Heart Rate (HR). The aim of the study was to find out correlation between CRF and Heart Rate Recovery (HRR) in PCOS and PCOS with hypothyroidism patients. **Methods:** Newly medically diagnosed not on medications total 43 subjects were recruited, subjects were divided into group A (PCOS; n=33) and group B (PCOS with hypothyroidism; n=10). Anthropometric measurements were taken, CRF was assessed by 3 min YMCA submaximal step test and autonomic function tests for assessing parasympathetic function such as heart rate response to immediate standing (IS) (30:15) and Standing to Lying ratio (S:L) were employed, Electrocardiogram (ECG) machine (RMS-Vesta 301i electrocardiograph) was used for assessing parasympathetic function then measurements was taken according to the respective scoring procedures. **Results:** Negative correlation was observed in S:L test in PCOS group and IS test in PCOS with hypothyroidism group and positive correlation was observed in IS test in PCOS group and S:L test in PCOS with hypothyroidism group. No significance was found between HRR and CRF in PCOS as well as PCOS with hypothyroidism in our studied population. **Conclusion:** CRF was not a predictor of HRR in studied population, thus we conclude that CRF has no short-term effect on HRR in PCOS and PCOS with hypothyroid patients.

Keywords: Autonomic function test, Cardiorespiratory fitness, Heart rate recovery, Hypothyroidism, Polycystic ovary syndrome.

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INTRODUCTION

The autonomic nervous system is the part of the nervous system that is responsible for regulation and integration of internal organ's functioning. Together with the endocrine and immunological systems, it determines the status of the internal environment of the organism and adjusts it to its demands, thus enabling adaptation of the internal environment to changes in the external environment.[1]

Individuals who present better cardiovascular performance during physical exercise in cardiopulmonary testing also present greater Heart Rate Recovery (HRR), characterized by a greater decrease in Heart Rate (HR) in a shorter period. This recovery is a morbidity and mortality predictor in patients with cardiovascular diseases.[2,3] Post-exercise HRR is therefore considered as a simple non-invasive measurement related to autonomic nervous system dysfunction that indicates impaired parasympathetic reactivation and/or sympathetic withdrawal after exercise.[4,5] Many studies have shown that blunted HRR at 1min, defined as a ≤12 beats/min decrease in HR from peak exercise to 1 min into recovery, is a powerful predictor of cardiovascular morbidity and overall mortality[6] and also HRR at 1 min has been reported to be an independent predictor of endothelial function and with delays potentially caused by autonomic dysfunction or imbalance. Heart Rate (HR) and Heart Rate Variability (HRV) are important markers of cardiac autonomic function. Autonomic nervous system responses, in particular parasympathetic reactivation, are a major determinant of HRR.

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Cardiorespiratory Fitness (CRF) is a health-related component of physical fitness defined as the ability of the circulatory, respiratory and muscular systems to supply oxygen during sustained physical activity. CRF is usually expressed in Metabolic equivalents (METs) or maximal oxygen uptake (VO2 max) measured by exercise tests such as treadmill or cycle ergometer. CRF is at least as important as the traditional risk factors and is more strongly associated with mortality.[7] The ANS and the thyroid gland are closely interlinked by their controlling center, the hypothalamus and also by their effects on the cardiovascular system.[8] Thyroid dysfunction can lead to ovulatory dysfunction, menstrual irregularity and infertility. So, both of these endocrine conditions have profound effects on reproductive function in women. In the presence of hypothyroidism, ovarian morphology becomes polycystic. Rise in Thyrotropin-Releasing Hormone (TRH) in primary hypothyroidism leads to increased prolactin and Thyroid Stimulating Hormone (TSH).[9]

Slightly raised prolactin has been observed in PCOS. Raised prolactin levels have been documented in children and adults with mild subclinical hypothyroidism, which also may contribute to the overlapping features of menstrual irregularity seen both in hypothyroidism and PCOS.[10]

Previously studies suggested hypothyroidism is a common finding in PCOS and both are linked to each other and also investigated low CRF and autonomic dysfunction in PCOS patients and hypothyroid patients. Therefore the aim of the study was to find out correlation between CRF and HRR in PCOS and PCOS with hypothyroid patients.

MATERIALS AND METHODS

This study was carried out in Hakeem Abdul Hameed Centenary Hospital (HAHC), Department of Obstetrics and Gynecology, Jamia Hamdard, New Delhi in the year 2019-2020. Total 43 participants were recruited. Only newly diagnosed not on medications subjects were selected to avoid the effects of medications on testing, these subjects were divided into group A PCOS (n=33) and group B PCOS with hypothyroidism (n=10). By convenient method of sampling participants were selected and a pool of participants were screened for the study based on inclusion and exclusion criteria. Female participants of age between 18-30 years and BMI +18.5 to 30 kg/m^2 were included. Patients with diagnosed diabetes mellitus and hypertension, with any recent surgical history like abdominothoracic surgery, spinal surgery, cardiac conditions and pulmonary condition like asthma, CHD, valve disease, those with any orthopedic condition which may hamper patient's testing like rheumatoid arthritis, genu valgum, genu varum etc., pregnancy, smokers and alcoholics were excluded from the study. All the participants performed heart rate response to 30:15 and S:L test, ECG machine (RMS-Vesta 301i electrocardiograph) was used for assessing parasympathetic function then the data was recorded in both groups of participants.

Assessment of Heart Rate Recovery

Patients were instructed to come after a light meal and to refrain from any caffeinated drinks on the day of testing. All testing of autonomic functions was done after they were familiarized with the testing procedure and after informed consent was taken from the subjects.

The tests carried out were:

HR response to immediate standing (30:15)

In the supine position, after a rest of 15 min, the ECG leads were positioned and ECG recording was started, then the patient was asked to stand from the supine position without displacing the leads. The 30:15 ratios was calculated by taking the ratio of longest R-R interval around beat 30 and shortest R-R interval around beat 15 after standing.

Standing to lying ratio (S-L ratio)

In standing position, ECG was recorded for 20 beats and then the patient was asked to lie down with the leads attached as fast as possible. The ECG recording continued for 60 more beats in the lying position. The point at which subject started to lie down was marked. S/L ratio was calculated as the longest R-R interval during 5 beats before lying down to shortest R-R interval 10 beats after lying down.

Assessment of Cardiorespiratory Fitness (CRF)

CRF was assessed by 3 min YMCA step test. The YMCA 3 min step test measures aerobic (cardiovascular) fitness level based on how quickly the heart rate returns to normal after exercise. This test is based on the principle that the step test provides a submaximal measure of cardio-respiratory or endurance fitness. For this test, we used 12 inch (30 cm) step, stopwatch, metronome or cadence tape, stethoscope. Procedure was explained to the subject. Basic information such as age, height, body weight, gender, test conditions was recorded. The procedure was demonstrated by alternating stepping cadence to the subject. In time with the beat, one foot on the bench was stepped up (1st beat), stepped up with the second foot (2nd beat), stepped down with one foot (3rd beat) and stepped down with the other foot (4th beat.) The subjects were allowed to practice the stepping cadence according to the metronome, which was set at 96 beats/min (4 clicks=one step cycle) for a stepping rate of 24 steps/min. The subjects stepped up and down on the platform at the given rate for a total of 3 min. The subjects were instructed to sit down immediately after completion of the test. Within 5 sec, the tester is to count the subject's heart rate (ideally with a stethoscope) for one complete minute. The total 1 min post-exercise heart rate was the subject's

score for the test, the age-adjusted standards based on guidelines published by YMCA.

Statistical Analysis of Data

Statistical data analysis was done with the help of SPSS (Statistical Package for Social Sciences) version 16 software for windows. Correlation between HRR and CRF was done using Pearson correlation. p value of <0.05 was considered as statistically significant.

RESULTS

Correlation of CRF and HRR in PCOS Group

Table 1 shows the correlation of CRF and HRR in PCOS patients. HRR on immediate standing was observed to be positively correlated with cardiorespiratory fitness with the coefficient value of 0.115 which indicated weak correlation. Whereas, HRR on S:L was found to be negatively correlated with CRF with the coefficient value of -0.005. However, CRF and HRR on immediate standing and S:L were found not to be statistically significant with p values of 0.52 and 0.97 as depicted in Table 1 and Figures 1 and 2.

Correlation of CRF and HRR in PCOS with Hypothyroidism Group

There was a positive coefficient correlation between CRF and HRR on S:L with the coefficient value of 0.371 which indicated weak correlation. Negative coefficient correlation was observed between HRR on immediate standing and CRF with the coefficient value of -0.215 which indicated weak correlation. CRF and HRR on immediate standing and S:L were found not to be statistically significant with p values of 0.55 and 0.29 as depicted in Table 2 and Figures 3 and 4.

DISCUSSION

Post-exercise HRR has been widely utilized as a simple measure of cardiac autonomic control, particularly parasympathetic reactivation.[6,11,12] Previous studies have indicated that heart rate variability during the monitoring of training was related to CRF[13] while HRR was influenced by the applied exercise load.[14]

Table 1: Correlation analysis between CRF and HRR (IS+S:L) in PCOS Group.

	Group-A (PCOS)	Immediate Standing (IS) (30:15)	Standing-to-lying ratio (S:L)
CRF	Pearson Correlation	0.115	-0.005
	Sig. (2-tailed)	0.524	0.976

p value <0.05 considered to be statistically significant. CRF: Cardiorespiratory fitness; HRR: Heart rate recovery.

Table 2: Correlation analysis between CRF and HRR (IS+S: L) in PCOS with hypothyroid Group.

GROUP-B (PCOS with hypothyroidism)		Immediate Standing (30:15)	Standing to Lying ratio (S:L)
CRF	Pearson Correlation	-0.215	0.371
	Sig. (2-tailed)	0.552	0.292

p value <0.05 considered to be statistically significant. CRF: Cardiorespiratory fitness; HRR: Heart rate recovery.

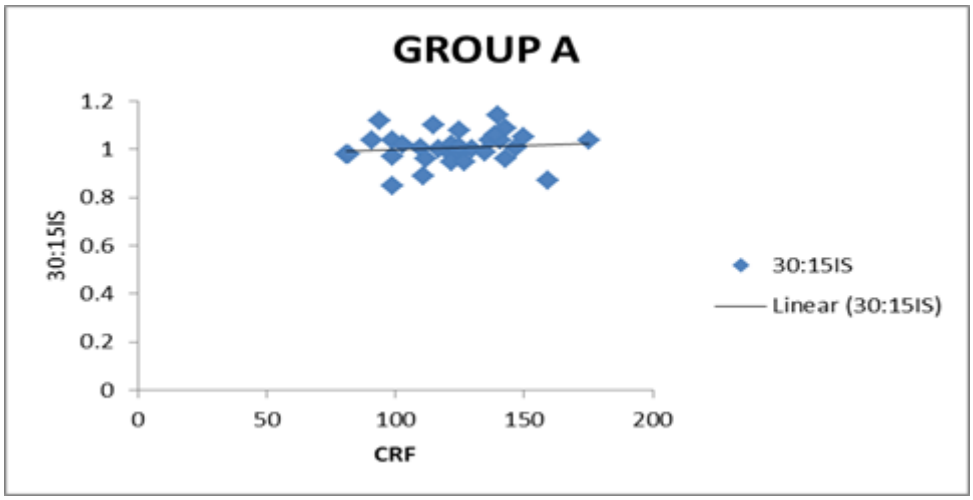

Figure 1: Correlation between CRF and HR response to Immediate Standing (IS)-30:15 in PCOS group.

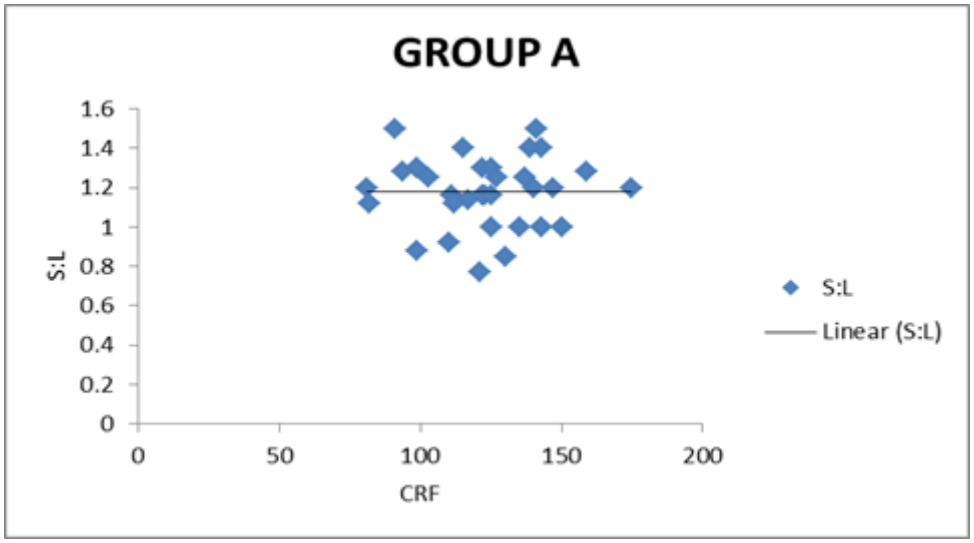

Figure 2: Correlation between CRF and HR response to Standing to Lying ratio (S:L) in PCOS group.

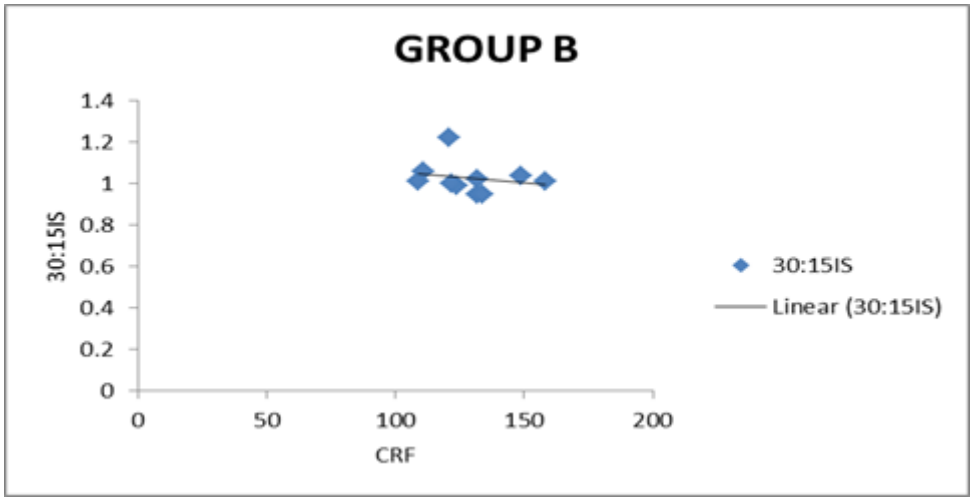

Figure 3: Correlation between CRF and HR response to Immediate Standing (IS)-30:15 in PCOS with hypothyroidism group.

In the present study, we observed positive correlation at IS test in PCOS and S:L test in PCOS with hypothyroidism and negative correlation between S:L test in PCOS subjects and in IS test in PCOS with hypothyroidism subjects. Our results corroborated the literature as they showed no relation between CRF and HRR values. Therefore our study found no significance between CRF and HRR in PCOS as well as in PCOS with hypothyroidism. Our study aligns with the findings of research conducted by Buchheit M *et al.*[14] They suggested that Heart Rate Variability (HRV) indexes are linked more to VO2 max, whereas post exercise HR recovery. Our study results were also in agreement with those of a study by Lais Tonello *et al.*[15] They suggested greater post-exercise HRR was associated with greater Physical Activity (PA) that reflects the unique pertinence of PA for enhancing parasympathetic reactivation.

According to the literature, the marked reduction in HR, immediately after exercise, might be related to a decrease in cardiac output by intrinsic self-regulation. The ejection volume remains higher in trained individuals due to redirection of peripheral blood to central regions, which increases venous return and facilitates ventricular filling.[16] It has also been suggested that physical training might promote alterations in cardiac autonomic balance, characterized by an autonomic balance more favorable towards vagal component activity.[2] Thus, it is likely that individuals with greater cardiorespiratory fitness present a different cardiovascular autonomic activity balance, when compared to individuals with lower cardiorespiratory fitness. However, a higher vagal activity is different from a higher vagal cardiac autonomic modulation and the same observation applies to the sympathetic component. There results suggest that CRF has no short-term effect on HRV, Blood Pressure Variability (BPV) and Baroreflex Sensitivity (BRS), reorganization in healthy young and middle age men's after a submaximal exercise test and hypothesized that cardiovascular autonomic control is already operating properly in healthy individuals, independently of their

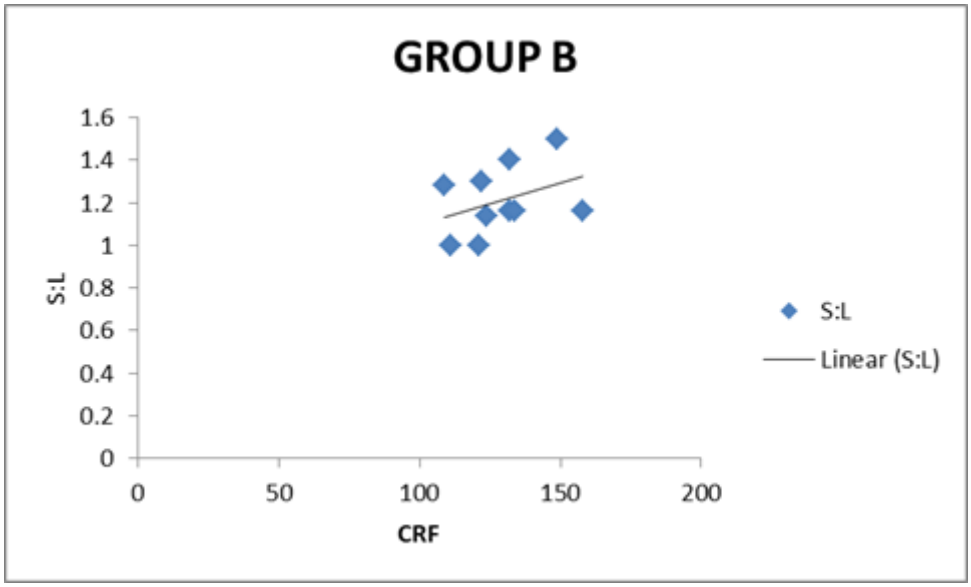

Figure 4: Correlation between CRF and HR response Standing to Lying ratio (S:L) in PCOS with hypothyroidism group.

CRF, thus physical training would have no additive effect. Thus, level of physical conditioning, in general, does not influence the cardiovascular parameters analyzed in the study, during recovery after submaximal exercise.[2]

A study by Marco Herbsleb *et al*.[17] stated that HRR 1min has been reported to be an independent predictor of endothelial function and delayed due to autonomic dysfunction or imbalance. But in their patient population, they observed only a non-significant trend for lower HRR 1min. The significantly lower HRR 8-10 min observed in their patients could be in part a consequence of the higher baseline heart rate in the group due to sympathetic modulation and found a correlation of baseline HR as well as HRR 8-10 min with VO2VT1. They suggested that the sympathetic over activity might be the key alteration of the aberrant autonomic modulation in Major Depressive Disorder (MDD). The study results indicate that sympathetic predominance might be related to reduce CRF in these patients. However, in contrast to patients with schizophrenia,[18] they have not observed any further correlation between other indices of autonomic function (e.g. HRV) and CRF, suggesting that the impact of the autonomic state on CRF might be less severe.[17] Present study reported that there was a poor correlation between HRR and CRF in both the groups. In contrast to the previous studies that showed positive relationship between CRF and HRR, we found no relationship between them in our studied population.

CONCLUSION

The current study has defined the relationship between CRF and HRR in a group of PCOS and PCOS with hypothyroid and concluded CRF was not a predictor of HRR in studied population, thus we conclude that CRF has no short-term effect on HRR in PCOS and PCOS with hypothyroid patients.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

AFT: Autonomic Function Test; **PCOS:** Polycystic Ovary Syndrome; **CRF:** Cardiorespiratory Fitness; **HRR:** Heart Rate Recovery; **TSH:** Thyroid Stimulating Hormones; **BMI:** Body Mass Index.

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