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Research Article

Comparison of cardiac vagal activity between pre and postmenopausal women using heart rate recovery

I. Vijayalakshmi[1]*, K. C. Subha[2], R. Niruba[2]

[1]Department of Physiology, Vinayaka Mission Medical College, Salem, Tamil Nadu, India
[2]Department of Physiology, Anapoorna Medical College, Salem, Tamil Nadu, India

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***Correspondence:**
Dr. I. Vijayalakshmi,
E-mail: drvijibalu@yahoo.com

ABSTRACT

Background: Ageing is associated with an increase in Heart Rate Recovery (HRR). HRR is a property of vagal activity. But there is little evidence regarding the extent to which age-related changes in HRR depend on simultaneous transition from pre-menopausal state to postmenopausal state. The purpose of this study was (i) to compare HRR between pre and postmenopausal women, (ii) to compare heart rate recovery between men of age group 40-45 years and 45-50years respectively (iii) and to determine whether difference in age, gender and body composition could account for the difference in HRR between pre- and post-menopausal groups.
Methods: HRR was assessed using modified Bruce exercise protocol. The body mass index was assessed by measuring weight and height of the subject. Data was analyzed after adjusting for age and body composition.
Results: It was found that the HRR were significantly higher (P <0.001) in postmenopausal women compared to that of premenopausal women. Analysis after adjusting for age and gender revealed that men of same age group didn't undergo much change in HRR as compared to women.
Conclusions: The study concludes that both ageing and declined oestrogen levels are associated with the increased Hear Rate Recovery (HRR) seen among postmenopausal women.

Keywords: Heart rate recovery, Premenopausal women, Postmenopausal women

INTRODUCTION

Autonomic control of the heart plays an important role in cardiac mortality.[1] One of the main characteristics of the autonomic control to heart is the constant modification of heart rate on beat-to-beat basis. Heart Rate Recovery (HRR) is mainly thought to be due to parasympathetic reactivation and has been shown to be a remarkable complement to a medical and/or physical assessment of an individual.[2] Clinical application of HRR after exercise has been widely studied. A delayed decline of heart rate has been associated with increased risk of cardiovascular mortality, autonomic dysfunction, diabetes, endothelial dysfunction, and metabolic syndrome.[3]

Heart rate recovery can be defined as the rate at which the HR declines from either maximal or sub maximal exercise to resting levels.[4] HR recovery to resting levels can take one hour after light or moderate exercise, four hours after long-duration aerobic exercise, and even up to 24 hours after intense or maximal exercise and has been suggested to depend on the interaction among factors like exercise intensity, cardiac autonomic modulation, and the level of physical fitness.[5] Investigators have measured the change in HR from peak exercise to 1 or 2 minute of recovery or considered the slope of the decline.[6] At the end of the exercise a decrease of 15-20 beats per minute (bpm) in the first minute of recovery has been shown to be typical for a healthy person.[7] A first minute reduction of post-exercise HR less than 12 bpm if recovery is active

or 18 bpm if recovery is passive in the supine position after a maximal exercise test, represents an unfavourable prognosis for relative risk of cardiovascular mortality in asymptomatic individuals and cardiopaths.[8]

Menopause is multidimensional and influenced by many endogenous and exogenous factors mainly perceived as reproductive hormone deficiency.[9] Their deficiency affects many metabolic and physiological functions within the women's body including cardiovascular system. Epidemiological studies have indicated that women have a lower incidence of cardiovascular disease compared to their male counterparts but this difference becomes decreased after menopause.[10] A difference in risk for cardiovascular disease between pre-menopausal and postmenopausal women is not explained by any of the classic risk factor for heart disease. A cardio protective role for oestrogen is supported by the observation that the excess risk of cardiovascular disease in women who underwent oophorectomy in young adulthood is prevented by oestrogen. In addition, data shows a significant reduction in the risk of heart disease in women who take oestrogen after a non-surgical menopause.[11] Analysis of HRR among pre and post-menopausal women can be used to evaluate the adaptations of autonomic nervous system in women related changes due to ageing, decreased beneficial effects of natural oestrogen and altered body composition. Because incidence of cardiovascular illness increases with ageing in women rising sharply approximately at the time of menopause, this study postulated that premenopausal women have greater HRR than post-menopausal women. Further, difference in HRR among pre-menopausal women could be associated with age, difference in oestrogen level and body fat.[12]

Over the last several years, clinical evaluation of HRR as a prognostic tool for diagnosing CVD has been the subject of interest, with little attention given to its physiological importance. To our knowledge, limited information exists regarding the use of HRR as a cardiovascular fitness indicator in menopausal women. Thus we hypothesized to study the role of menopause over HRR with the following objectives (i) to compare HRR between pre and postmenopausal women, (ii) to compare HRR between men of age group 40-45 years and 45-50 years respectively (iii) and to determine whether difference in age, gender and body composition could account for the difference in HRR between pre- and post-menopausal groups.

METHODS

This cross-sectional study was conducted to assess the Heart Rate Recovery (HRR) in pre- and post-menopausal women in a total of 120 healthy nonathletic volunteers.

Of the selected 60 were females and 60 were males were categorized into following four groups,

Group I: consisted of 30 premenopausal women between the age group of 40-45 years having regular menstrual cycle.

Group II: consisted of 30 post-menopausal women between the age group of 45-50 years who had menopause naturally at least 2 years before.

Group III: consisted of 30 men in the age group of 40-45 years and

Group IV: consisted of 30 men in the age group of 45-50 years.

After detailed medical history of the subjects those with diabetes, hypertension, obesity or other cardiovascular disease were excluded from the study. Also, those with a history of smoking and alcoholism, any recent illness were excluded. Women on oral contraceptive pill, hormonal replacement therapy, drugs that alter the cardiovascular functions were also excluded from the study. Informed written consent was obtained from all the participants. Ethical clearance was obtained from the institution.

All the 120 subjects underwent a modified Bruce exercise protocol testing. Along with the bio data, height and weight of the subjects were recorded. Resting heart rate and resting blood pressure were measured on an electronic blood pressure recording machine after the subjects were made to rest for one hour. The electronic blood pressure recording machine was checked for calibration. The experiments were carried out in the morning in fasted state. Subjects refrained from caffeinated beverages for at least 12 hours prior to the experiments and had completed their evening meal by 9 P.M. They were also instructed to avoid strenuous physical activity from the previous evening.

Exercise protocol

The modified Bruce exercise protocol was done on a treadmill. The modified Bruce exercise protocol is a description for the increments in speed and gradient in the treadmill test which starts at a lower work load than the standard test and is typically used for elderly or sedentary patients.[13] During the time of testing, continuous monitoring of the subjects heart rate and blood pressure was done. The patients were advised to stop if any chest pain or discomfort occurred. Tab sorbitrate and tab. disprin were kept ready to be administered to the subjects if any chest pain arises during the exercise.

This exercise protocol consisted of total of four stages, each stage of 3 minutes duration. Thus, the total duration of exercise was of 12 minutes. The speed of treadmill remained 46 meters per minute in the first three stages and was increased to 67 meters per minute in the last stage. The gradient of treadmill was increased from 0, 5,

10 and 12 through the four stages respectively.[14] The table below gives a detailed description of the modified Bruce exercise protocol.

Table 1: Modified Bruce protocol.

Stage	Speed (meters /min)	Grad -ient	Duration (min)	Cumul -ative time (min)	Cum distance (meters)
1.	46	0	3	3	138
2.	46	5	3	6	276
3.	46	10	3	9	414
4.	67	12	3	12	615

During the exercise, the peak heart rate of the subjects was measured. After the 12 minutes exercise regime, the subjects were asked to sit and rest. The heart rate was recorded after an interval of one minute, two minutes and five minutes of rest. The heart rate recovery is calculated by subtracting peak heart rate with heart rate at one minute after exercise to get heart rate recovery at one minute. Similarly, heart rate recovery at two minute and five minute was calculated.[15,16]

The data thus generated were administered in the MS excel spreadsheet. Repeated measure ANOVA with Tukey's test at 5% level of significance was used. All analysis was done using SPSS 17.0.

RESULTS

Since vagal activity denotes the autonomic function of cardiovascular system which has been identified by many literatures as a significant risk marker, we conducted the study to identify the role of menopause in the cardiovascular outcome of women which may be the effect of oestrogen.

To state this, we have compared the Heart Rate Recovery HRR in four groups as explained before. The comparison between group I (pre-menopausal women) and group II (post-menopausal women) may identify the effect of oestrogen on HRR and the comparison between women of same age group with the men will exclude the confounding phenomenon such as age on HRR. Thus isolated phenomenon mentioning effect of oestrogen over HRR as a marker of vagal activity can be analyzed by making these comparisons with the analysis of variants (ANOVA) statistical techniques to derive the above statement.

On performing ANOVA test, there seems to be a significant difference (Table 2) between the groups which facilitated us to carry out individual comparisons within the groups. From Table 3, there is a statistical significant difference in HRR between pre- and post-menopausal women with mean difference of 5.167 ±0.470.

Table 2: Overall comparison of heart recovery rate among the four study groups.

Study groups	HRR (Mean ± SE)	ANOVA between groups
I-Premenopausal women (40-45 years)	22.33 ± 0.372	F=238.850 P <0.05
II-Post menopausal women (45-50 years)	17.17 ± 0. .455	
III-Men (40-45 years)	28.57 ± 0. .243	
IV-Men (45-50 years)	27.00 ± 0. 192	

Table 3: Inter group comparison of heart rate recovery among the study groups.

Group comparisons on HRR		Mean difference of HRR	P value
Premenopausal women (40-45 years)	Postmenopausal women (45-50 years)	5.167 ± 0.470	0.000
Premenopausal women (40-45 years)	Men (40-45 years)	6.23 ± 0.470	0.000
Postmenopausal women (45-50 years)	Men (45-50 years)	1.567 ± 0.470	0.000

Comparison of the same age group of men and women in both pre and post-menopausal women shows a statistical significant difference stating that age being a confounding factor with mean difference of 6.23 ± 0.470 and 1.567 ± 0.470 respectively.

Thus, from these observations it is evident that only the HRR is better among pre-menopausal women with age group of 40-45 years than that of post-menopausal women with age group of 45-50 years which may be the autonomic effect of oestrogen over the cardiovascular system.

As well as removing the age as confounding factor on comparison with same age group of men again strengthens the this predominant effect of improved HRR among premenopausal women may be due to the oestrogen effect.

DISCUSSION

Over the last several years, clinical evaluation of HRR as a prognostic tool for diagnosing CVD has been the subject of interest, with little attention given to its physiological importance. Despite several facts emanating from several prognostic and few physiological investigations which suggest that HRR is a plausible index of cardiovascular health, and a remarkable complement to the medical and physical assessment of an

individual, it is often overlooked as an indicator of cardiovascular fitness.

To our knowledge, limited information exists regarding the use of HRR as a cardiovascular fitness indicator. Available literatures on cardiovascular fitness have mainly included such variables as resting Heart Rate (HR), resting blood pressure (BP), cardiac output, Stroke Volume (SV), maximum oxygen consumption (VO_{2max}), endurance capacity, HDL cholesterol, body fat, glucose-stimulated insulin, and total cholesterol, as the major indicators of cardiovascular fitness.

With the existing evidence on heart rate recovery as a predictor of mortality, this cross sectional study was conducted to postulate effect of oestrogen by comparing heart rate recovery among pre & post-menopausal women with sex and age matched comparison groups.

Extensive literature search about the study on heart rate recovery among post-menopausal women is not available. Thus we searched the articles related to the exercise physiology and heart rate physiology among the post-menopausal women, which even ended in very minimal published articles.

In our study, it was observed that heart rate recovery is better among the premenopausal women when compared with post-menopausal as well as men of same age group, which denotes the improved autonomic function of the cardiovascular system. Similarly in a study conducted by Gautam S et al., it was observed that postmenopausal women had alteration in their autonomic status with higher sympathetic and lower vagal tone compared to premenopausal women.[17]

In this current study, it was observed that significant effect of decreased cardiac autonomic activity among post-menopausal women might be due to depletion of oestrogen and ageing, similar findings were observed by Moodithaya SS et al. They concluded that both ageing and declined oestrogen levels are associated with the autonomic alterations seen among postmenopausal women.[18]

Heart rate recovery is a readily obtainable, relatively inexpensive and very simple diagnostic and prognostic tool that reflects the ANS and cardiac functions and which clinicians can employ in cardiac rehabilitation settings. It is known that abnormalities of the ANS are related with death risk but the way these abnormalities are measured are difficult and require sophisticated equipment and tests. As part of a regular routine exercise testing, HRR will provide the clinicians with prognosis for patients who are at risk of death and those who are at low risk. Similarly, it will provide to the exercise physiologists and physical fitness personnel, a guide for exercise prescription and help evaluate the physical fitness status of an individual.

In the present study we used HRR to evaluate the possible cardiovascular health risk in postmenopausal women. On comparison with the previous literature and from our study, we found that, the effect of oestrogen in the cardiovascular outcome has been clearly identified. Thus clinical implication of these study findings such as hormone therapy and delayed menopausal effect may improve the cardiovascular health of women inclusive of the connective tissue disorders.

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