Original Article

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Physiology Section

Effect of Short Term Resistance and Endurance Exercise Training on Resting Heart Rate and Inflammatory Marker in Young Adults: A Cross-sectional Study

SHIVAM BISHNOI[1], NEENA SRIVASTAVA[†2], SUNITA TIWARI[3], ARCHANA GHILDIYAL[4], WAHID ALI[5], MONISHA BANERJEE[6]

ABSTRACT

Introduction: In a normal healthy adult, sympathetic and parasympathetic system should be in synergy. Measuring resting heart rate is a one of the methods to assess health condition. It can be affected by different factors such as exercise, mental health, any disease, etc. Normal subjects with reduced heart rate are associated with better cardiovascular health. Physical inactivity is associated with high level of inflammatory markers. Increased inflammatory markers are related to inflammation and chronic diseases. The C-Reactive Protein (CRP) is a biomarker of inflammatory diseases. High CRP level is a potent risk factor for obesity, diabetes, atherosclerosis, etc.

Aim: To study the effect of short term resistance and endurance exercise training on resting heart rate in healthy young adults, CRP, Body Mass Index (BMI) and also to compare the changes between two exercise groups.

Materials and Methods: A cross-sectional study was conducted from May 2019 to May 2020 in the Department of Physiology at King George's Medical University, Lucknow, Uttar Pradesh, India. The study included 60 healthy young adults with normal BMI (18.5-24.9 kg/m^2) and age between 18-25 years. Subjects were equally divided into Group I- Resistance exercise and Group II endurance groups. Subjects did moderate intensity exercise (based on maximum heart rate) for five days in a week for eight weeks. Endurance group did jogging. Resistance group did push-up, pull-up and squats. Target heart rate during moderate intensity of activities was 64-76% of maximum heart rate. Heart rate measurement was done before the start of exercise and after five to seven minutes of exercise when it reached 64-76% of maximum heart rate. It was measured by pulse oximeter. Follow-up was done after eight weeks of exercise training in both the groups. Evaluation was done by comparing resting heart rate and CRP level before the start of training and after the completion of training programme. Statistical analysis was done using student t-test and paired t-test.

Results: Mean age of subjects of group I was found to be higher (19.98±1.26 years) as compared to group II (19.97±0.98 years). Mean pre intervention BMI of both the groups was found to be similar (21.97±1.78 kg/m^2). No statistically significant change in resting heart rate was found in both resistance group (p=0.096) and endurance group (p=0.326) after exercise training. Statistically significant increase in CRP was found in resistance group (p<0.001) and endurance group (p<0.001). The increment in CRP was more in endurance group (55.04%) than resistance group (35.34%).

Conclusion: Short duration of exercises increase inflammation but no significant effect on resting heart rate was seen.

Keywords: Body fat composition, Body mass index, Diabetes, Mortality, Obesity

INTRODUCTION

Increased CRP level is related to chronic inflammation and high BMI [1,2]. Increased CRP is related to insulin resistance, endothelial dysfunction and colorectal, esophageal cancers etc., [3-5]. High level of CRP is associated with metabolic syndromes, hypertension and cardiovascular diseases [6-8]. The chronic inflammation leads to atherosclerosis [9]. Short term resistance and endurance training reduces CRP level [10].

Resting heart rate is related to function of left ventricle and psychosocial factors [11,12]. Heart rate is affected by different factors such as exercise, mental health, smoking, gender [13]. An increased heart rate is associated with metabolic dysfunction and cardiovascular mortality [14,15]. High resting heart rate is associated with hypertension and diabetes [16,17]. Short term exercise reduces resting heart rate [18].

If the exercise is done for short period, initially body takes some time to adopt to that and there is release of some inflammatory markers to combat to that sudden change, but after some time body starts responding positively and levels of inflammatory markers start reducing [19]. Studies have been performed previously but mostly in diseased conditions [20,21]. Most of the studies [19-21] regarding exercise have been done in western countries including western population but present study includes Indian population. It also includes apparently healthy subjects while most of the other studies include diseased subjects.

Every exercise has different response, so hypothesising this present study was planned with an aim to compare the effect of short term resistance and endurance exercise trainings on resting heart rate, CRP and Body Mass Index (BMI) in both the exercise groups.

MATERIALS AND METHODS

A cross-sectional study was conducted from May 2019 to May 2020 in the Department of Physiology, King George's Medical University, Lucknow, Uttar Pradesh, India. Ethical approval was taken by the Institutional Ethical Committee (Reference code: 96th ECM II B-Thesis/P41). A written informed consent was taken by subjects. Subjects were selected from students studying at King George's Medical University, Lucknow, Uttar Pradesh, India. Subjects were recruited after taking detailed history and considering strict inclusion and exclusion criteria. Subjects were equally divided into resistance group (Group I) and endurance group (Group II).

†Author succumbed to COVID-19 in July, 2021

Sample size calculation: Using BMI between resistance and endurance group, μ_1=30.32, μ_2=31.47 [22]

$$n=\frac{2\sigma^2(z_{1-\alpha}+z_{1-\beta})^2}{(\mu_1-\mu_2)^2}$$

($Z_{1-\alpha}$)-Value of two tailed α 95% confounding level=1.96

($Z_{1-\beta}$)-Value of β error for 80% power=0.84

Putting all values in above formula; (n=27) subjects in each group was required but we consider 30 subjects in each groups so the total sample size of 60 was considered.

Inclusion criteria: Apparently healthy young male adults with age 18-25 years, normal BMI- 18.5-24.9 kg/m^2, no history of any medication and without any acute or chronic illness such as Chronic Obstructive Pulmonary Disease (COPD), Tuberculosis (TB), bronchitis, endocrinal disorders were included.

Exclusion criteria: Subjects with age <18 or >25 years, BMI <18.5 or >24.9 kg/m^2, doing regular gym, sports persons, athletes, history of the drug intake, alcohol, tobacco or caffeine abuse, having any acute or chronic illness were excluded.

Females were not selected in the study because hormone fluctuation during the female menstrual cycle can affect the regularity of training programme.

Exercise Training Protocol

Subjects did moderate intensity exercise (based on maximum heart rate) for five days in a week for eight weeks.

- Resistance exercise group (Group I) did push-ups, pull-ups and squats for 30 minutes. Two sets of ten push-ups, ten pull-ups and ten squats, each lasting for 15 minutes.
- Endurance exercise group (Group II) did jogging for 30 minutes. Two sets of jogging, each lasting for 15 minutes.

Target heart rate during moderate intensity of activities was 64-76% of maximum heart rate [23]. Maximum heart rate is calculated by substracting the present age (in years) from 220 [24].

Heart rate measurement was done before the start of exercise and after five to seven minutes of exercise when it reached 64-76% of maximum heart rate. It was measured by pulse oximeter (AccuSure, model no-FS10E). Follow-up was done after eight weeks of exercise training in both the groups. Evaluation was done by comparing resting heart rate and CRP level before the start of training and after the completion of training programme. CRP level assessment was done twice before and after completion of exercise training programme in both groups with the help of Hs-CRP ELISA kit in Pathology Department, KGMU, Lucknow, Uttar Pradesh, India. (Enzyme Immunosorbent assay test kit catalog No. 10603).

STATISTICAL ANALYSIS

The data was analysed using Statistical Package for Social Sciences (SPSS) version 21.0. All the quantitative variables (resting heart rate, CRP, age, BMI) were mentioned inform of Mean±SD. All the qualitative variables were mentioned in form of frequency (%). Resting heart rate and CRP were taken as dependent variables and type of exercise (resistance and endurance) was taken as independent variable. The data was analysed using Student t-test and Paired t-test. Student t-test was used for comparing resting heart rate and CRP level between groups. Paired t-test was used for intragroup comparison of resting heart rate and CRP level. The p-value less than 0.05 were considered significant.

RESULTS

Mean age of subjects of group I was found to be higher (19.98±1.26 years) as compared to group II (19.97±0.98 years). Mean BMI of both the groups was found to be similar (21.97±1.78 kg/m^2) [Table/Fig-1]. Mean resting heart rate of subjects of group I was found to be higher as compared to group II at pre intervention (75.73±1.26 vs 75.73±1.70 beats/min) as well as at post intervention (75.57±1.70 vs. 75.50±1.68 beats/min). Differences in resting heart rate of above two groups were not found to be significant either at pre intervention (p-value=0.606) or at postintervention (p-value=0.857) [Table/Fig-2]. In both the groups decline in pre intervention resting heart rate was observed after intervention though it was statistically insignificant. In group I, a decline of 0.17±0.53 beats/min and in group II, a decline of 0.03±0.18 beats/min in pre intervention heart rate was observed. This change was found to be statistically insignificant in both resistance group (p-value=0.096) and endurance group (p-value=0.326). In group I percent post intervention change in heart rate was higher (0.22%) as compared to group II (0.04%) [Table/Fig-3].

Parameter	Resistance exercise	Endurance exercise
Age (Mean±SD) years	19.98±1.26	19.97±0.98
Weight (Mean±SD) kg	66.33±9.59	65.87± 9.47
BMI (Mean±SD) kg/m^2	21.97±1.78	21.97±1.78
Race	Asian	Asian
Type of exercise	Push-ups, pull-ups, squats	Jogging

[Table/Fig-1]: Socio-demographic characterstics.

Groups	Range		Mean	SD	95% CI	
	Min	Max			Lower bound	Upper bound
Pre intervention						
Group I (R) (n=30)	74.00	78.00	75.73	1.26	75.26	76.20
Group II (E) (n=30)	71.00	78.00	75.53	1.70	74.90	76.17
Total (n=60)	71.00	78.00	75.63	1.48	75.25	76.02
Student t-test			t=0.519; p=0.606 (NS)			
Post intervention						
Group I (R) (n=30)	74.00	78.00	75.57	1.70	75.14	75.99
Group II (E) (n=30)	71.00	78.00	75.50	1.68	74.87	76.13
Total (n=60)	71.00	78.00	75.62	1.47	75.17	75.90
Student t-test			t=0.180; p=0.857(NS)			

[Table/Fig-2]: Group comparison of Pre and post intervention resting heart rate (per min).
NS: Non significant

Groups	Mean change	SD	% Post intervention change	t-value	p-value
Group I (R)	-0.17	0.53	-0.22	-1.720	0.096 (NS)
Group II (E)	-0.03	0.18	-0.04	-1.000	0.326 (NS)
Total	-0.02	0.13	-0.02	-1.000	0.321 (NS)

[Table/Fig-3]: Intragroup change in Pre and post intervention resting heart rate.
Paired 't' test was used; NS: Non significant

Pre intervention CRP levels of group I (1.00±0.43 mg/L) was found to be higher as compared to group II (0.98±0.37 mg/L) while post intervention CRP levels of group II (1.52±0.48 mg/L) was found to be higher than that of group I (1.35±0.38 mg/L). Differences in CRP level of above two groups were not found to be significant either at pre intervention (p-value=0.847) or at post intervention (p-value=0.144) [Table/Fig-4]. After intervention statistically significant increment in pre intervention CRP levels was observed in both resistance group (p-value <0.001) and endurance group (p-value <0.001). An increase of 0.35±0.23 mg/L was observed in group I and an increment of 0.54±0.39 mg/L was observed in group II. Percent post intervention increment was higher in group II (55.04%) as compared to group I (35.34%) [Table/Fig-5]. Mean pre intervention BMI of both the groups was found to be similar (21.97±1.78 kg/m^2). Mean post intervention BMI of group I (21.49±1.51 kg/m^2) was found to be higher than that of group II (20.66±1.42 kg/m^2). This difference was found to be significant statistically [Table/Fig-6]. After intervention significant decline in pre intervention BMI was observed in both the groups. In group I decline in BMI was 0.47±0.70 kg/m^2 while in group II decline in BMI was 1.31±0.67. On evaluating the % post intervention change in group I and group II, it was observed

that decline in group II (5.95%) was higher as compared to group I (2.15%) [Table/Fig-7].

Groups	Range		Mean	SD	95% CI	
	Min	Max			Lower Bound	Upper Bound
Pre intervention						
Group I (R) (n=30)	0.13	1.71	1.00	0.43	0.84	1.16
Group II (E) (n=30)	0.13	1.47	0.98	0.37	0.84	1.12
Total (n=60)	0.13	1.71	0.99	0.40	0.89	1.09
Student t-test			t=0.193; p-value=0.847 (NS)			
Post intervention						
Group I (R) (n=30)	0.63	2.11	1.35	0.38	1.21	1.50
Group II (E) (n=30)	0.49	2.14	1.52	0.48	1.34	1.70
Total (n=60)	0.49	2.14	1.44	0.44	1.32	1.55
Student t-test			t=-1.483; p-value=0.144 (NS)			

[Table/Fig-4]: Group comparison of pre and post intervention C-Reactive Protein (CRP) (mg/L).
NS: Non significant

Groups	Mean change	SD	% Post intervention change	t-value	p-value
Group I(R)	0.35	0.23	35.34	8.582	<0.001
Group II (E)	0.54	0.39	55.04	7.558	<0.001
Total	0.45	0.33	45.09	10.478	<0.001

[Table/Fig-5]: Intragroup change in pre- and post intervention C-Reactive Protein (CRP) levels (Paired t-test).

Groups	Range		Mean	SD	95% CI	
	Min.	Max.			Lower bound	Upper bound
Pre intervention						
Group I (n=30)	18.60	24.90	21.97	1.78	21.30	22.63
Group II (n=30)	18.60	24.90	21.97	1.78	21.30	22.63
Total (n=60)	18.60	24.90	21.97	1.77	21.51	22.42
Student t-test			t=<0.001 (Sig); p-value >0.05 (NS)			
Post intervention						
Group I (n=30)	18.50	24.60	21.49	1.51	20.93	22.06
Group II (n=30)	18.50	23.60	20.66	1.42	20.13	21.19
Total (n=60)	18.50	24.60	21.08	1.52	20.69	21.47
Student t-test			t=2.198; p-value=0.032 (Sig)			

[Table/Fig-6]: Between group comparison of pre and post intervention Body Mass Index (BMI) (in kg/m^2).
NS: Non significant; Sig: Significant

Group	Mean change	SD	% Post intervention change	t-value	p-value
Group I	-0.47	0.70	-2.15	-3.708	0.001 (Sig)
Group II	-1.31	0.67	-5.95	-10.748	<0.001 (Sig)
Total	-0.89	0.80	-4.05	-8.653	<0.001 (Sig)

[Table/Fig-7]: Intragroup change in pre and post intervention Body Mass Index (BMI) (Paired t-test).
Sig: Significant

DISCUSSION

In the present study, resistance exercise training caused decrease in resting heart rate though it was statistically insignificant (p-value=0.096). These findings are in accordance to Reimers AK et al., who studied the effect of resistance training on heart rate and found that there is decline in heart rate after training [25]. In the present study endurance exercise caused decrease in resting heart rate though it was statistically insignificant (p-value=0.326).

These results favour the studies of Yılmaz T, and Dağlıoğlu Ö, and Reimers AK et al., who studied the effect of endurance training on heart rate and observed that there is decline in heart rate after training [18,25]. The results of study of Broadbent S et al., are not in favour of this study, who conducted a study in which it was observed that short term exercise training increases resting heart rate [26].

Both exercise trainings caused insignificant decrease in resting heart rate. It might be due to that exercise training caused increased parasympathetic tone and decreased responsiveness to beta adrenergic receptor [27]. In the present study, subjects who performed resistance exercise training showed statistically significant increase in CRP level after exercise (p-value <0.001).

The findings of study are similar to Mohammadi HR et al., who studied the effect of resistance exercise on CRP and observed that there is increase in CRP level after exercise [28]. Subjects who completed endurance exercise training showed statistically significant increase in CRP level after exercise (p-value <0.001). The results of present study are supported by Kasapis C and Thompson PD and Mouridsen MR et al., who studied the effect of endurance exercise on CRP and observed that there is increase in CRP after exercise [29,30]. In a study Arikawa AY et al., found that regular endurance exercise reduces CRP level [31]. Kim KB conducted a study in which he found that endurance and resistance training reduces CRP level [10].

Both resistance and endurance exercise caused CRP to be increased in both groups. This might be due to that short term exercise worked as stress response on body and caused tissue damage. This triggered release of IL-6. IL-6 caused liver to produce acute phase protein such as CRP. This caused increase in CRP level [32]. In the present study, resistance exercise training caused statistically significant decrease in BMI (p-value=0.001). In the present study, endurance exercise caused statistically significant decrease in BMI (p-value <0.001). The findings of present study are similar to Mohammadi HR et al., who studied the effect of aerobic and strength exercise on body composition and found that there is decrease in BMI after exercise [28]. The results of present study are supported by Chaudhary S et al., who studied the effect of aerobic and resistance exercise on body composition and found that there is decrease in BMI after exercise [22].

The effect of exercise on CRP is determined by many factors such as age, sex, race, baseline CRP level, baseline BMI, weight of the subjects, type of exercise etc. The condition of subject, whether the subject is healthy or having some chronic disease such as obesity, diabetes, cardiovascular diseases or other diseases, have effect on CRP level. All these factors may act as confounders. So all the confounders were taken into consideration and such subjects were not included in this study. A combination of both types of exercises may be helpful in improving the cardiac health as well as in strengthening the muscles all over the body. Including this combination of exercise schedule in day to day life may promote overall health of the individuals. This could be taken as guidance for making workout plans for the people to promote a healthy life style.

Limitation(s)

Less time duration was the limitation in this study which could be addressed in future research.

CONCLUSION(S)

Short duration of exercises increase inflammation but no significant effect on resting heart rate was seen. This might be due to short duration of training programme and less number of subjects. Detailed further studies with larger number of subjects and long duration exercise training are required to warrant the results.

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PARTICULARS OF CONTRIBUTORS:
1. Junior Resident, Department of Physiology, King George's Medical University, Lucknow, Uttar Pradesh, India.
2. Professor, Department of Physiology, King George's Medical University,Lucknow, Uttar Pradesh, India.
3. Professor and Head, Department of Physiology, King George's Medical University, Lucknow, Uttar Pradesh, India.
4. Professor, Department of Physiology, King George's Medical University, Lucknow, Uttar Pradesh, India.
5. Additional Professor, Department of Pathology, King George's Medical University, Lucknow, Uttar Pradesh, India.
6. Professor and Dean, Department of Zoology, King George's Medical University, Lucknow, Uttar Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Neena Srivastava[†],
Professor, Department of Physiology, King George's Medical University,
Lucknow, Uttar Pradesh, India.
E-mail: drshivambishnoi91@gmail.com

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