Original Article

Chronic effects of aerobic and resistance exercise on cardio-metabolic profile in healthy nonobese subjects

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Abstract

Background and Aim: Exercise is considered the best preventive measure for cardiovascular (CV) morbidity. But, it is of paramount importance to know the type of exercise that provides maximum benefits. This study was planned to compare various CV and biochemical parameters in subjects performing different types of exercise.

Methods: The study was performed on young healthy nonobese volunteers divided into three groups: Sedentary controls, resistance exercise and aerobic exercise groups. In all the groups, CV parameters viz., heart rate (HR) and blood pressure (systolic and diastolic) were measured and the blood sample were analyzed for fasting blood glucose (FBG), lipid profile, serum creatinine, blood urea, uric acid and C-reactive protein (CRP) using standard procedures. This was followed by comparison of these parameters among the three groups.

Results: HR ($P = 0.002$), systolic blood pressure ($P = 0.021$) and rate pressure product ($P = 0.003$) were significantly low in aerobic group in comparison to the sedentary controls as well as in resistance group. FBG ($P = 0.010$), total cholesterol ($P < 0.001$), low density lipoprotein ($P < 0.001$), triglyceride ($P = 0.012$) and lipid risk factors ($P < 0.001$) were significantly lower in subjects performing aerobic exercises than in subjects performing resistance exercises and in sedentary controls. Serum high-density lipoprotein (HDL) ($P < 0.001$) was significantly higher in resistance and aerobic groups than in the control group. Serum creatinine was found to be significantly higher in the aerobic group with no significant difference in CRP level among the three groups.

Conclusion: Aerobic exercises might have extra benefits due to less myocardial oxygen consumption and load, and increasing HDL. However, as creatinine level gets altered due to aerobic exercise in the absence of any renal damage, this should be taken into consideration while assessing renal functions in these individuals.

Key words: Aerobic exercise, C-reactive protein, creatinine, lipid profile, resistance exercise

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INTRODUCTION

Exercise is considered the best way to stay fit[1]. It helps in maintaining hemodynamic, cardiovascular (CV) and biochemical homeostasis in the body and keeps these parameters within normal range.[2] Regular exercise helps in maintaining the blood pressure within normal limits and also reduces harmful cholesterol and increases high-density lipoprotein (HDL). Other than lipid profile, laboratory indices that may be of considerable importance to assess the benefits of exercise or adverse effects of vigorous exercise are serum creatinine, uric acid (UA) and C-reactive protein (CRP).[3,4] Raised serum creatinine in exercising individuals is often suggestive of the extent of damage to the skeletal muscles but may be erroneously interpreted as renal dysfunction.[3] Similarly, CRP is an index of inflammation and stress and is measured to assess the extent of stress or inflammation caused by vigorous exercise.[4] These biochemical parameters and CV effects vary with the type of exercise performed, resistance or aerobic. Hence, this study was taken up to compare the above mentioned biochemical and CV parameters in subjects performing regular aerobic and resistance exercises.

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MATERIALS AND METHODS

The study was conducted at All India Institute of Medical Sciences, Jodhpur on 60 nonobese adult volunteers

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after obtaining clearance from the institutional ethical committee. Subjects were all males aged between 18 and 30 years and body mass index (BMI) < 30 m/kg^2 (as per WHO guidelines).[5]

Inclusion criteria for subjects in the three groups were sedentary subjects, subjects engaged in aerobic exercises, subjects who perform resistance body weight exercises like squats, lunges, pushups, crunches, planks along with free weight exercises (barbells and dumbbells) and weight machine exercises like seated leg press, shoulder press etc, for atleast 3 years. Obesity and presence or history of any CV, respiratory or metabolic disorders were excluded from the study.

The subjects were divided into three groups:

Control group: Subjects with a sedentary lifestyle, who perform <30 min of physical activity per day[6]

Aerobic group: Subjects involved in aerobic exercises like running/jogging, brisk walking, cycling, etc

Resistance group: Subjects involved in resistance exercises like squats, lunges, pushups, crunches, planks along with free weight exercises (barbells and dumbbells) and weight machine exercises like seated leg press, shoulder press, etc.

A thorough history using a standard questionnaire,[7] with special emphasis on the dietary, smoking and drinking habits was taken and was ensured that the subjects of all the three groups had similar habits of smoking, drinking and diet. All the subjects were physically examined, and their anthropometric measurements were recorded after explaining the procedure/study design and informing them that the findings were a part of the study. Subjects with similar dietary, smoking and drinking habits were included in the three groups. The privacy and confidentiality of the subjects were maintained throughout the study.

Resting heart rate (HR), systolic blood pressure (SBP) and diastolic blood pressure was recorded, and rate pressure product (RPP) was calculated using the formula: RPP = (HR × SBP)/100.[8]

Fasting blood sample was collected and processed differently, depending on the sample required, serum or plasma.

The following laboratory indices were estimated by standard procedures:

- Blood glucose estimation: By glucose oxidase peroxidase method, carried out on a Beckman Coulter auto analyzer
- Lipid profile estimation:
    a. Total cholesterol by cholestrol oxidase peroxidase method
    b. Direct HDL and direct low-density lipoprotein (LDL) by immuno-turbidimetric method on auto analyzer
    c. Triglycerides (TG) were analyzed by enzymatic methods.
- Serum creatinine was estimated by Jaffe's method
- CRP by immuno-turbidimetric method
- Blood urea by ureas method
- Serum UA by Urikase method.

Statistical analysis of data

Statistical analysis was done using SPSS version 17 (SPSS Software Inc, Chicago, IL, USA) and GraphPad Prism 5 (California, USA). Statistical significance was calculated using One-way ANOVA followed by Tukey's multiple comparison tests. A $P < 0.05$ was taken as significant.

RESULTS

As depicted in Table 1, the subjects were age matched, nonobese individuals with BMI < 30 kg/m^2. The HR was significantly low in the aerobic group in comparison to both the other groups ($P < 0.05$). SBP was significantly lower in the aerobic group when compared to the resistance group. RPP was also significantly lower in the aerobic group ($P < 0.001$).

There were significant differences in fasting blood glucose (FBG) levels and lipid profiles in the three groups as depicted in Table 2. FBG, serum cholesterol, LDL and TG were significantly low in the aerobic group in comparison to the resistance group and controls

Table 1: The baseline characteristics and cardiovascular parameters of the subjects in control, aerobic and resistance exercise groups

Parameters	Control (*n*=20)	Aerobic (*n*=20)	Resistance (*n*=20)	*P*
Age (years)	23.10±2.94	25.40±3.57	23.10±2.85	0.064
BMI (kg/m^2)	24.8±2.97	23.28±2.56	24.96±4.68	0.123
Heart rate (bpm)	75.95±4.06	70.80±2.57**	74.15±6.09*,#	0.002
SBP (mmHg)	121.2±3.00	118.2±5.72	121.7±2.92#	0.021
DBP (mmHg)	82.6±6.78	76.5±6.39	76.7±6.39	0.545
RPP (mmHg/min)	91.93±5.23	83.66±4.65***	90.29±8.41##	0.003

Data expressed as mean±SD. Comparison of data between various parameters was done by One-way ANOVA followed by Tukey's *Post-hoc* test. *Comparison with control group, #Comparison with aerobic training group, *P<0.05, **P<0.01, ***P<0.001, #P<0.05, ##P<0.01. BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, RPP: Rate pressure product, SD: Standard deviation, bpm: Beats per minute

Table 2: The values of various biochemical parameters in control, aerobic and resistance exercise groups

Parameters	Control (*n*=20)	Aerobic (*n*=20)	Resistance (*n*=20)	*P*
Blood glucose (mg/dl)	89.05±6.46	82.39±9.64*	90.35±9.11#	0.010
TC (mg/dl)	164.4±36.44	110.4±17.70**	148.8±34.64###	<0.001
LDL (mg/dl)	125.2±15.59	99.47±5.77***	109.5±16.44**	<0.001
TG (mg/dl)	136.8±31.62	108.8±19.82*	138.2±41.86#	0.012
HDL (mg/dl)	46.05±5.18	62.5±1.91***	54.25±3.09***,###	<0.001
TC/HDL	3.63±0.93	1.77±0.29***	2.75±0.64***,###	<0.001
TG/HDL	3.03±0.82	1.75±0.35***	2.55±0.77##	<0.001
Atherogenic index	0.46±0.12	0.24±0.08***	0.39±0.13###	<0.001
Serum creatinine (mg/dl)	0.99±0.26	1.17±0.30	0.98±0.22#	0.029
Blood urea (mg/dl)	24.5±5.52	22.94±4.12	25.7±5.65	0.260
Serum uric acid (mg/dl)	3.93±0.85	3.62±1.06	3.87±0.81	0.870
CRP (mg/dl)	3.31±1.53	2.91±1.06	3.76±6.72	0.0920

Data expressed as mean±SD. Comparison of data between various parameters was done by one-way ANOVA followed by Tukey's *Post-hoc* test. *Comparison with control group, #Comparison with aerobic training group, **P*<0.05, ***P*<0.01, ****P*<0.001, #*P*<0.05, ##*P*<0.01, ###*P*<0.001. TC: Total cholesterol, LDL: Low density lipoprotein, HDL: High density lipoprotein, TG: Triglyceride, CRP: C-reactive protein, SD: Standard deviation

[Table 2]. Serum HDL was significantly higher in both resistance and aerobic groups than in controls, more so in subjects performing aerobic exercises than those performing resistance exercises ($P < 0.05$). Serum creatinine was found to be significantly higher in the aerobic group in comparison to the resistance group. No significant differences were observed in UA, urea and CRP levels among the three groups ($P > 0.05$) [Table 2].

DISCUSSION

In this study, we investigated various CV and biochemical parameters in subjects engaged in aerobic/endurance training and resistance training.

HR was significantly low along with SBP in the aerobic group. The lowering of HR with regular exercise has been related to increased vagal tone with training.[7] Dynamic aerobic exercise reduces systemic vascular resistance, with the possible role of sympathetic nervous system and renin-angiotensin system.[1,2] Very few studies have demonstrated the role of resistance exercise on CV system, unlike our finding, blood pressure lowering effect has been documented in various studies.[9,10]

It was found that serum cholesterol, LDL and TG were significantly lower and HDL was significantly higher in subjects doing aerobics in comparison to resistance training and sedentary healthy controls. Such findings have been reported by other authors as well.[11-13] Similar to our findings, all parameters of lipid profile except, HDL were lower in elite basketball and soccer players compared to the controls.[11] Acute effects of sports on lipid profile were also reported. A 90 min soccer match was found to decrease TG, LDL but not HDL and cholesterol levels.[12] They reported that cholesterol levels are affected only by long-term exercise and not influenced by an acute bout of exercise. Similarly, LeMura *et al*. demonstrated that aerobic type of exercise improves lipid profile, cardiorespiratory fitness and body composition in healthy young women, while resistance training improves upper and lower body strength only.[14] Females engaged in leisure time aerobic physical activities also showed similar results when compared to sedentary controls. Physically active women had lower total cholesterol, LDL, TG and apolipoprotein B, and higher levels of HDL and apolipoprotein A_1 compared with controls.[15] Physical exercises and sports activity in adolescent girls are associated with mildly oxidized LDL, influencing the atherogenic risks favorably.[13] As documented by others and as corroborated by our findings, it could be postulated that aerobic recreational activities are capable of favorably altering the lipid profile, whereas recreational resistance exercises do not alter lipid profile to that extent.

In the present study, FBG was significantly lower in aerobic trainees as compared to resistance trainees and healthy controls. FBG concentration is maintained by the balance between skeletal muscle uptake and adequate concentrations of both insulin and counter insulin hormones. In diabetic individuals, exercise has variable effects on FBG, exercise improves insulin action and reduces CV risk factors by increasing insulin sensitivity, thereby decreasing blood glucose levels. Not much has been studied on the role of different types of exercises on FBG levels in healthy adults. Russell *et al*. showed that short bouts of high-intensity resistance training produce reductions in FBG of diabetic offspring as well as controls.[16] Contrary to this, our study proved that aerobic exercises reduce FBG significantly, whereas resistance exercise has no FBG lowering effect.

Serum UA and blood urea did not differ significantly among the three groups in this study. Studies have shown a linear association between hyperuricemia and grip strength. This effect is attributed to the anti-oxidant property of UA.[17,18] On the other hand, few workers have shown hyperuricemia to be associated with poor muscle strength.[19] UA was found to be significantly low in elite endurance athletes in comparison to sedentary controls.[3] Normal UA and urea levels with raised creatinine by aerobic exercises as observed in our study, rule out the presence of chronic kidney disease.

In this study, no difference in the CRP among the three groups was reported. CRP, an index of acute inflammation is not much affected by chronic exercise. Some studies have correlated the acute intensity of exercise with the levels of CRP. CRP was found to increase in male athletes after 24 h relay record performance.[20] Dufaux *et al*. investigated that CRP levels were lower in swimmers and rowers in comparison to sedentary healthy controls, although no significant difference was observed in cyclists and soccer players.[4] The cause of this difference is not clearly explained but is suggestive of the suppressive effect of training on CRP.

Serum creatinine levels in our study were significantly high in the aerobic training group than in resistance training group and sedentary controls. Reports available with regards to creatinine level and exercise are inconsistent. A correlation between creatinine and BMI in elite athletes competing in different sports has been shown.[21] Banfi *et al*. suggested that athletes should be periodically monitored by consecutive creatinine level assessments, and values reported while the training and competition season should be compared with the baseline levels recorded during the recovery period. In general, creatinine is not influenced by training or competition,[22] although, some increase has been reported in endurance performances.[23] Creatinine concentration also depends on the type of sports the athlete performs. Lower creatinine in professional cyclists and Nordic skiers than sedentary healthy people was reported.[3] Contrary to this, Kratz *et al*. observed increase in creatinine with decrease in body weight.[23] Since serum creatinine levels are influenced by change in BMI in athletes, cystatin C may be considered as a reliable marker of glomerular filtration rate in sports personnel, as it is not influenced by age, gender and BMI.[24]

Limitations of the study

The major limitation of the study is the less sample size, for which the association of cardio-metabolic profile with the type of exercise could not be derived. Also, we have not studied the effect of BMI on exercise induced cardio-metabolic changes.

CONCLUSION

We conclude that the aerobic exercise is most useful as it maximally decreased RPP and increased HDL in comparison to resistance exercises. Since, creatinine level is increased due to exercise, this should be taken into consideration while assessing the renal functions in these individuals. Sedentary life-style should be abandoned, and majority of people should opt for aerobic outdoor activities, rather than gymnasium work-outs.

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