ASSESSMENT OF GENDER AND BMI DIFFERENCES ON HEART RATE AND SYSTOLIC BLOOD PRESSURE IN YOUNG HEALTHY ADULTS AFTER ENDURANCE EXERCISE TRAINING

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Abstract : Introduction: Cardiac automaticity is intrinsic to various pace maker tissue, which are largely under control of autonomic nervous system, the heart rate in the normal healthy individual represents the net effect of cardiac sympathetic and parasympathetic nervous system on myocardial activity. **Methods:** The present study aims to examine and analyse the pattern of blood pressure (BP) and heart rate (HR) before and after endurance exercise training on the Bicycle ergometer, in healthy young adults (50 males, 50 females). An attempt has been made to assess the effect of endurance exercise training on systolic blood pressure (SBP) and heart rate (HR) in non-athletic young adults during the first 6 min of exercise and also its effect on gender and basal metabolic rate. A randomized crossover study over a period of 8-week period involving 100 sedentary men and women was performed; participants exercised at lower or higher intensity (50% or 70% of HR reserve) in random order, with a sedentary period in between. Training programmes were identical for both gender except for intensity, and were performed under supervision daily for 2 hr. **Results**: The results showed that endurance exercise training reduces SBP significantly ($p<0.001$) both in males and females when analysed it shows reduction in SBP at different intensity of exercise but BMI showed no significant changes. The effect of exercise training on HR showed reduction in HR significantly at rest and also reduced significantly as the intensity of exercise increases when both the gender taken tougher($P<0.001$), when we compared males and females separately no significant decrease was seen in case of HR. **conclusion:** Endurance exercise training, significantly decreases the systolic blood pressure and heart rate, which tells the improvement of the parasympathetic activity which in turn helps our understanding of the development of cardio vascular disease (CVD).

Keywords: Exercise, systolic blood pressure, intensity, endurance, parasympathetic

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INTRODUCTION:

The cardio vascular system is mostly controlled by the autonomic nervous system though the complex interplay between the parasympathetic and sympathetic division[1]. Cardiac automaticity is intrinsic to various pace maker tissue, which are largely under control of autonomic nervous system, the heart rate in the normal healthy individual represents the net effect of cardiac sympathetic and parasympathetic nervous system on myocardial activity[2]. Exercise is an activity that enhances and maintains physical fitness and ensures overall health or wellness that may include strengthening of muscles, the cardiovascular system, and for enjoyment as well.

Despite conflicting evidence on the antihypertensive effect of dynamic exercise on resting BP, aerobic exercise, in addition to diet modification and drug therapy, is frequently recommended by physicians and allied health professionals for the treatment of hypertension[3,4], although the long-term influence of physical training on resting arterial BP has been widely studied[5-8]. Because exercise is only one of many stresses to which humans can be exposed, it is more appropriate to call an exercise test not a 'stress test'. This is particularly relevant considering the increased use of non-exercise stress tests[9]. As exercise is initiated and intensity of exercise increases, there is increasing oxygen demand from the body, usually from the working muscles. To meet the requirements, cardiac output is increased by an augmentation in stroke volume (mediated through the Frank-Starling mechanism) and heart rate as well as an increasing peripheral arterio venous oxygen difference. However, at moderate to highintensity exercise, the rise in cardiac output is primarily attributable to an increase in heart rate, as stroke volume reaches a plateau at 50% to 60% of maximal oxygen uptake except in elite athletes. Thus, maximal cardiac output during exercise is the product of both stroke volume and heart rate. The immediate response of the cardiovascular system to exercise is an increase in heart rate that is attributable to a decrease in vagal tone, followed by an increase in sympathetic outflow. During dynamic exercise, heart rate in sinus rhythm increases linearly with workload and oxygen demand[9]. The expected value of heart rate can be predicted from one of several available equations, which are derived separately for men and women. The basic way to calculate maximum heart rate is to subtract age from 220[10]. It is known that moderate exercise intensity results in 50-70% of maximum heart rate, and vigorous exercise results in 70-85% of maximum heart rate.

The regular practice of physical exercises is an important factor to reduce morbidity and mortality rates of cardiovascular and all other conditions[11,12]; there also seems to have further and independent benefits from the practice of physical exercises and improvement of the aerobic condition[13-14],

Purpose of this study is to assess the effect of endurance exercise training on systolic blood pressure (SBP) and heart rate (HR) in non-athletic young adults during the first 6 min of exercise also its effect on gender and BMI.

MATERIAL AND METHODS

One hundred healthy adults in age group of 18-25 years (50 Male sand 50 females) volunteered to participate in the study. Clearance from the Institutional Ethical Committee was obtained before undertaking the study. The study was conducted in the Physiology department Laboratory. Participants were instructed not to consume beverages containing alcohol or coffee and not to eat a heavy meal immediately before the test. The study was conducted during morning hours after light breakfast, and commenced with the measurement and recording of the body weight, height and body mass index of the subjects. Height was measured in centimetres without footwear using a vertically movable scale. Weight was measured to the nearest 100 grams by using a digital scale. Body Mass Index was derived by Quetelet Index. Resting blood pressure was measured using a digital electronic blood pressure monitor (manufactured by Kawamoto corporation, Osaka – Japan model no: KBM-25), with the subject resting in a supine posture for 15 minutes. Measurement was done two times during two different visits to the laboratory. On the occasion of each visit, blood pressure was measured by the same experienced observer using a digital electronic blood pressure monitor. Subjects were excluded if the average of the last two values obtained during each visit for systolic and diastolic blood pressures was greater than 139 and 89 mmHg respectively. Subjects were excluded if they had a history of cardiovascular, peripheral vascular, respiratory disease and orthopaedic or musculoskeletal lesions. Subjects selected were nonathletic but physically active, non-smokers, non-alcoholics, non-obese, non-diabetics, non-asthmatics, non-hypertensive, apparently healthy and free of cardiovascular and respiratory diseases any disorder; which would interfere the autonomic responses or is a contraindication for exercise as per the guidelines given by American college of sports medicine, and not taking medications that could affect cardiovascular functions. A written informed consent was obtained from each participant after explaining about the objectives of the study. All the individuals were asked to do cycling on bicycle ergo meter, During the first six minutes of exercise, the heart rate was monitored by using the inbuilt electronic display device of the bicycle ergo meter, which showed the pulse rate of the exercising subjects, and SBP was measured by the digital electronic blood pressure monitor. All the individuals were subjected to physical training for 8 weeks in early morning hours in the department of physiology for two hours for six days in a week. Physical training includes warm up exercise followed by jogging; the duration of exercise was personally supervised by instructor, after that each subject exercised on a bicycle ergo meter with a gradually increasing intensity every 3 minutes, starting from 50 watts, Moderate exercise intensity was calculated as 50 to 70 percent of maximum heart rate i.e. 100 to 140 heart beats per minute, exercise was stopped immediately when the individual complains of any discomfort. After completion of 8 weeks of physical training the individuals were again subjected for exercise test and the procedure was repeated to study any change in the HR, SBP.

Descriptive data are presented as means ± SD. Test of normal distribution of data was analysed. Student t-test was used to compare the differences between values. The accepted level of significance for differences was equal to or less than 0.05 for all tests (P value< 0.05).

RESULTS

In our study males were aged 19.14±1.30 and females were 19.18±1, 35. General characteristics of

Subjects (by age, gender and BMI) (table 1)

Table 1: Basal characteristics of the study population by age and gender.

When compared the HR and SBP in females before and after exercise training showed that SBP had significantly reduced at rest and during exercise, whereas HR reduced after exercise but significant changes seen at rest and in 1st and 4th min of exercise, (table 3)

Table 3: Comparison before and after training in females

		Before Training	After Training	t-test Value	P-value
		Mean ± SD	Mean ± SD		
At Rest	HR	73.87 ± 4.880	70.35 ± 4.810	33.548	<0.001

SBP significantly reduced during first six minutes of exercise after the endurance exercise training for 8 weeks, in all the participants, whereas HR reduced significantly (<0.001) at rest and in 1st, 4th, 5th, and 6th min after training, (table 2)

	Male	Female
Age	19.14 ± 1.309	19.18 ± 1.351
BMI	21.043 ± 2.63	20.673 ± 2.169

Table 2: Comparison before and after training for all

		Before Training	After Training	t-test Value	P-value
		Mean ± SD	Mean ± SD		
At Rest	HR	74.09 ± 4.112	70.50 ± 4.029	39.89	<0.001
	SBP	111.25 ± 5.476	109.35 ± 5.509	12.178	<0.001
1st Min	HR	95.52 ± 5.638	93.75 ± 5.502	11.145	<0.001
	SBP	122.97 ± 4.021	117.27 ± 4.173	36.223	<0.001
2nd Min	HR	104.55 ± 6.475	101.39 ± 11.559	3.460	0.001
	SBP	127.88 ± 4.384	126.93 ± 3.980	5.019	<0.001
3rd Min	HR	113.77 ± 7.122	111.83 ± 10.666	2.127	0.036
	SBP	133.14 ± 3.913	131.98 ± 4.082	9.637	<0.001
4th Min	HR	120.36 ± 7.620	117.44 ± 7.492	25.545	<0.001
	SBP	137.61 ± 4.458	135.11 ± 3.916	7.808	<0.001
5th Min	HR	128.51 ± 7.523	123.48 ± 13.542	4.896	<0.001
	SBP	141.09 ± 3.763	136.74 ± 10.736	4.312	<0.001
6th Min	HR	135.06 ± 7.700	129.64 ± 14.105	4.883	<0.001
	SBP	148.12 ± 3.582	140.84 ± 3.735	42.091	<0.001

	SBP	112.41 ± 5.662	110.41 ± 5.731	8.916	<0.001
1st Min	HR	95.46 ± 6.209	93.80 ± 6.101	6.212	<0..001
	SBP	124.20 ± 3.389	118.37 ± 3.361	28.312	<0.001
2nd Min	HR	104.37 ± 7.293	100.35 ± 14.843	2.390	0.020
	SBP	128.91 ± 4.362	128.13 ± 3.540	2.246	0.029
3rd Min	HR	113.56 ± 8.077	112.43 ± 13.635	.674	0.503
	SBP	134.30 ± 3.368	133.04 ± 3.792	5.686	<0.001
4th Min	HR	120.15 ± 8.412	117.13 ± 8.432	41.721	<0.001
	SBP	139.07 ± 3.143	136.30 ± 3.457	10.743	<0.001
5th Min	HR	128.13 ± 8.463	122.20 ± 17.442	3.117	0.003
	SBP	138.94 ± 3.935	141.96 ± 3.895	-8.064	<0.001
6th Min	HR	134.94 ± 8.640	128.22 ± 18.186	3.253	0.002
	SBP	73.87 ± 4.880	70.35 ± 4.810	33.548	<0.001

In males both the SBP and HR reduced after endurance exercise training, but significant reduction in SBP is seen at rest and in first 4 min of the exercise. Later as the intensity increases no significant reduction in SBP is seen. Whereas HR is reduced at rest and in 1st and 4th min of the exercise. (table 4)

Table 4: Comparison before and after training in males

		Before Training	After Training	t-test Value	P-value
		Mean ± SD	Mean ± SD		
At Rest	HR	72.46 ± 3.721	68.78 ± 3.448	25.049	<0.001
	SBP	112.44 ± 5.203	110.68 ± 5.089	8.663	<0.001
1st Min	HR	91.54 ± 3.732	90.18 ± 4.079	4.523	<0.001
	SBP	121.90 ± 4.523	116.06 ± 4.731	30.349	<0.001
2nd Min	HR	99.76 ± 4.284	95.32 ± 13.284	2.455	0.018
	SBP	127.02 ± 4.456	126.08 ± 4.553	14.145	<0.001
3rd Min	HR	108.56 ± 4.828	107.80 ± 13.155	.419	0.677
	SBP	132.16 ± 4.428	131.06 ± 4.662	4.730	<0.001
4th	HR	114.	111.9	13.8	<0.0

Min		76 ± 5.438	6 ± 5.260	59	01
	SBP	136.96 ± 4.096	134.06 ± 4.307	10.805	<0.001
5th Min	HR	122.98 ± 5.597	116.96 ± 16.235	2.950	0.005
	SBP	140.06 ± 4.191	135.22 ± 14.830	2.393	0.021
6th Min	HR	129.92 ± 6.761	123.30 ± 17.310	2.971	0.005
	SBP	147.74 ± 4.299	141.16 ± 4.112	28.994	0.000

When we compared HR and SBP in males and females before exercise training, we found that the resting HR in females is significantly more than the males but resting SBP is less in females without any significance, and during the time of exercise the HR is significantly more in females, (table 5)

Table 5: comparison of males and females before exercise training

		Before Training Mean ± SD	After Training Mean ± SD	t-test Value	P-value
At Rest	HR	75.72 ± 3.86	72.46 ± 3.72	4.300	<0.001
	SBP	110.06 ± 5.534	112.44 ± 5.20	-2.216	0.029
1st Min	HR	99.50 ± 4.24	91.54 ± 3.73	9.966	<0.001
	SBP	124.04 ± 3.14	121.90 ± 4.52	2.727	0.007
2nd Min	HR	109.03 ± 4.42	99.76 ± 4.28	11.006	<0.001
	SBP	128.74 ± 4.18	127.02 ± 4.46	1.991	0.049
3rd Min	HR	118.98 ± 4.88	108.56 ± 4.83	10.737	<0.001
	SBP	134.12 ± 3.06	132.16 ± 4.43	2.575	0.012
4th Min	HR	125.96 ± 4.87	114.76 ± 5.44	10.845	<0.001
	SBP	138.26 ± 4.75	136.96 ± 4.09	1.466	0.146
5th Min	HR	134.04 ± 4.54	122.98 ± 5.59	10.852	0.001
	SBP	142.12 ± *2.98*	140.06 ± 4.19	2.832	0.006
6th Min	HR	140.20 ± 4.49	129.92 ± 6.76	8.956	<0.001
	SBP	148.50 ± 2.67	147.74 ± 4.29	1.061	0.292

At the same time, after endurance exercise training in females and males both SBP and HR is reduced; but HR is significantly more in females than males both in resting state and during exercise. Whereas SBP does not show any significant changes. (Table 6)

Table 6: comparison of males and females after exercise training

		Before Training Mean ± SD	After Training Mean ± SD	t-test Value	P-value
At	HR	72.2	68.78	4.70	<0.0

Rest		2 ± 3.86	± 3.45	2	01
	SBP	108.02 ± 5.64	110.68 ± 5.08	-2.476	0.015
1st Min	HR	97.32 ± 4.30	90.18 ± 4.08	8.516	<0.001
	SBP	118.48 ± 3.13	116.06 ± 4.73	3.016	0.003
2nd Min	HR	107.46 ± 4.28	95.32 ± 13.28	6.151	<0.001
	SBP	127.78 ± 3.13	126.08 ± 4.55	2.175	0.032
3rd Min	HR	115.86 ± 4.86	107.80 ± 13.155	4.064	<0.001
	SBP	132.90 ± 3.19	131.06 ± 4.66	2.302	0.023
4th Min	HR	122.92 ± 4.94	111.96 ± 5.26	10.735	<0.001
	SBP	136.16 ± 3.19	134.06 ± 4.31	2.771	0.007
5th Min	HR	130.00 ± 4.49	116.96 ± 16.23	5.474	<0.001
	SBP	138.26 ± *2.87*	135.22 ± 14.83	1.423	0.158
6th Min	HR	135.98 ± 4.50	123.30 ± 17.31	5.013	<0.001
	SBP	140.52 ± 3.327	141.16 ± 4.11	-0.855	0.394

When compared With BMI less than 20 and more than 20 no significant changes seen in both the gender.

DISCUSSION

Exercise is a central characteristic of a healthy lifestyle, but the cardio protective Mechanisms underlying its effects are unclear. We conducted a randomized controlled trial contrasting the autonomic effects of aerobic conditioning in healthy, sedentary young men and women. The main results of the current report show that in both conditions that is, at rest and during exercise, aerobic training programmes reduce SBP significantly but not the HR.

The present results show comparable reductions of SBP at fixed absolute workloads during the maximal graded exercise test. The decrease in SBP ranged from 3–8mmHg, which is in agreement with previous studies showing a decrease in exercise SBP at fixed absolute workloads [15, 16]. An acute bout of exercise elicits a number of transient physiological responses, whereas accumulated bouts of acute exercise produce more permanent chronic adaptations that may be termed the exercise training response [17]. Some authors observe an immediate reduction in BP after a single bout of exercise. This phenomenon may have significant benefits by lowering BP for certain periods of the day[18]. However, most of the literature documenting BP reduction after acute exercise comes from sedentary participants, the possibility remains that this acute effect is merely owing to the effect of a novel stressor on a sedentary system[19]. Where as many authors have contradictory results to our study, Irrespective of the training programme, on an average, a single bout of exercise did not cause significant reductions in SBP in normotensive humans [20,21]. Further, only recently, others showed a reduction in BP after a short maximal field exercise in moderately trained soccer players. However, no control observation or non-athletes were included, hence it is difficult to interpret these results[22]. The present data further show that aerobic training programmes causes reductions in HR at the same absolute workloads during the graded exercise test, which is moreover, in agreement with others[23,24].

Age, Sex, education, Body weight, alcohol consumption, physical fitness, and medication have all been shown to affect the BP response to exercise independently and significantly[25]. Numerous physiologic differences exist between men and women including: height, weight, body composition, hormones and also haemoglobin levels[26]. Previous work shows contributing to enhancement of cardiac performance during aerobic exercise between genders, with different mechanism, where females have demonstrated a steep increase in ejection fraction with exercise, unlike men[27,28]. Women demonstrated no increase in stroke volume with exercise training, whereas heart rate increases in them[29], which is in agreement with our study.

LIMITATIONS

Our study was designed only to assess the effect of aerobic conditioning training on cardiac autonomic modulation. It was not designed particularly to examine gender differences and was not powered to detect such differences; we could not be certain that the both the groups exercised as expected. However, because the groups differed precisely as predicted on aerobic capacity after training, it indicates that participants exercised as instructed. As we studied healthy young adults, who are at low risk of heart disease, it could be argued that our findings lack public health significance. Such a view is inconsistent with evidence that atherosclerosis begins very early in life risk factors for adult coronary heart disease also characterize atherosclerosis in childhood. ''True primary prevention of atherosclerosis, as contrasted with primary prevention of clinically manifest atherosclerotic disease, must begin in childhood or adolescence.

WHAT IS KNOWN ABOUT TOPIC

1. Aerobic endurance training reduces SBP at rest and during submaximal exercise.
2. SBP is reduced after an acute bout of exercise in sedentary individuals.
3. HR is reduced after training period but so significant changes seen.

CONCLUSIONS

Our analyses suggest that although there is evidence for cardio protection through increased autonomic activity generated by aerobic exercise in our overall sample which gives a wealth of evidence of the health benefits of physical activity, no single study can justify modifying clinical and public health recommendations to engage in exercise. However, our findings, combined with evidence demonstrating a cardio protective effect of exercise training, support the hypothesis that aerobic conditioning, as a measure of parasympathetic activity, confers greater cardio protection.

A decrease in resting HR and SBP is perhaps the most obvious manifestation of regular physical activity. Continuous pulse data provide a useful simple index of the response to training. Underlying mechanisms include an altered autonomic balance, SBP at any given rate of exercise are lower after training, and this is being augmented by a strengthening of the skeletal musculature. These findings are consistent with the hypothesis that aerobic conditioning increases cardiac vagal modulation. However, a post hoc analysis suggested a gender effect on training-induced changes in SBP is more evident in females at higher intensity where as in males showed at lower intensity of work load. Further study is required to test this hypothesis and examine the operative mechanisms.

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Disclosure: No conflicts of interest, financial, or otherwise are declared by authors