Effect of Sports on Blood Pressure and Heart Rate Variability: An Interventional Study

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Abstract— *Lack of sufficient physical activity is the second most important contributor to preventable deaths trailing only to tobacco use. So an interventional study was conducted on University students to study effect of sports with Blood Pressure & HRV. Comparison was made between Non exercise control group (n=31) and exercise group (n=31). Exercise group had an intervention of atleast 60 minutes of various sports of moderate to vigorous intensity daily for one year. Various variables of Blood Pressure & HRV were assessed in both the groups and compared by student unpaired 't' test. It was observed in this study that Exercise group had significantly lowered SBP, DBP, MABP. Although there was no significant difference in both the group in frequency domain of HRV but in time domain RR Intervel was significantly lowered in exercise group thanthe other group. So it can be concluded that one hour of Sports intervention significantly decreased Resting Systolic, Diastolic and Mean Arterial Blood Pressure and significantly decreased Resting Heart Rate this indicates a good interplay or modulation between parasympathetic and sympathetic nervous system. So these sports activities should be motivated in college students by including in their daily curricular activities.*

Key words: Blood Pressure, Heart Rate Variability, Exercise, Sports

I. INTRODUCTION

A sedentary life style has been linked to 28% of deaths from leading chronic diseases.[1] Body Fitness Prolongs Life. [2] National programme for prevention and control of Non communicable diseases are already launched as India is expressing a rapid health transition with Non communicable diseases surpassing the burden of communicable diseases. [3] Hypertension is a chronic condition of concern due to its role in the causation of coronary heart disease, stroke and other vascular complication .It is the commonest cardiovascular disorder posing a major public health challenge to population in socio-economic and epidemiological transition. It is the one of the major risk factors for cardiovascular mortality ,which account for 20-50% of all deaths.[4] Heart Rate Variability (HRV) phenomenon is the oscillation in the interval between consecutive heartbeats as well as the oscillations between consecutive instantaneous heart rates. HRV has the potential to provide additional valuable insight into physiological and pathological conditions and to enhance risk stratification. Components of HRV provide measurement of the degree of autonomic modulation rather than of the level of autonomic tone, averages of modulation do not represent an averaged level of tone, in other words HRV measures fluctuation in autonomic inputs to heart rather than the mean level of autonomic inputs. Thus, both autonomic withdrawal and saturating high level of sympathetic input lead to diminished HRV.[5] Role of HRV in different medical areas that include Cardiology and cardiovascular diseases, Neurology, Diabetes mellitus, Glomerulonephrites with renal insufficiency, Pharmacological influence, Toxicology, Work-related stress, Medical ecology, Sports and Fitness, Applied psychology ,Unconventional medical treatments, Transport, army and cosmic medicine, Health (life) insurance.[6] Increased HRV has been

associated with lower mortality rate and is affected by both age and sex. During graded exercise, the majority of studies show that HRV decreases progressively up to moderate intensities, after which it stabilizes. There is abundant evidence from cross-sectional studies that trained individuals have higher HRV than untrained individuals. The results from longitudinal studies are equivocal, with some showing increased HRV after training but an equal number of studies showing no differences. The duration of the training program might be one of the factors responsible for the versatility of the results.[7]

II. METHODOLOGY

An Interventional study was conducted at in collaboration of Physiology department and Physical Education department of S.M.S. Medical College Jaipur. University students of 16-25 year aged who had answered 'NO' to all physical activity readiness questions[8] and given written informed consent for this study were included in this study. Students who have any acute or chronic illness were excluded from the study. Finally 62 students were selected and each one was interrogated as per predesigned semi-structured performa. Variable related to Blood Pressure & Heart Rate Variability were recorded along with other observations. Blood Pressure were recorded by sphygmomanometer[9] and Heart Rate Variability was evaluated as per procedure given by KK Deepak, AIIMS Delhi.[10] All the observations were taken in resting condition. Then these students were enrolled randomly and divided into two group through alternate allocation of enrolment.

One group consist of 31 students were engulf into various sports for atleast 60 minutes, is interventional group or 'Exercise group'. Some or the other type of sports were continued for one year in 'Exercise Group' Other remaining group of 31 students served as control as 'Non-Exercise group'. Blood Pressure and Heart Rate Variability was again assessed and recorded after 5 and 10 minutes of supine rest. ECG was also recorded in supine position for 5 minutes after 15 minutes of supine rest. ECG wave signals were continuously amplified, digitized and stored in computer for analysis of Time domain, Frequency Domain and Nonlinear Domain. For processing the detection of 'R' wave was done by HRV soft version 1.1 developed by AIIMS New Delhi.[10] All recording were visually examined and manually corrected if required abnormal beats and areas of artifact were automatically and manually identified and excluded from the study as and when required. Quantification of HRV was done after generation of tachogram.

2.1 Statistical Analysis

Data were summarized with in MS Excel 2007 in the form of master chart and analyzed with trail version of SPSS statistical software Version '16'. To infer the significant of difference between both groups unpaired't' Test was used and to find out the effect of physical activity in exercised group paired 't' test was used. Level of significance was set at a standard of $p < 0.05$.

III. RESULTS

When both groups were compared as per their means age it was found that there was no significant difference in age in both the group so they were well comparable. (Table 1)

On comparison of Non exercise Control Group and Exercise Group it was found that SBP, DBP and MABP were significantly lowered in Exercise group on resting position. (Table 1)

Table 1
Effect of Sports on Resting Blood Pressure

S. No .	Age (inYrs)	SBP	DBP	MABP
Control Group n = 31 Resting Blood Pressure mm Hg				
Mean	20.58	132.3	86.26	101.6
SD	1.822	8.15	5.483	5.559
Exercise Group n=31 Resting Blood Pressure mm Hg				
Mean	21.39	127.9	83.29	98.16
SD	1.706	9.115	6.078	6.352
Comparison t test for equality of means				
t- test	-1.799	2.012	2.019	2.277
p value df=60	.077	.049*	.048*	.026*
Significance	NS	S	S	S

***Significance at p value <0.05**

On comparison of Non Linear domain HRV in Non exercise Control Group and Exercise Group no significant difference was found on resting position. (Table 2)

Table 2
Effect of Sports on Resting Non Linear Domain HRV

S. No.	Age (in Yrs)	SD1	SD2	SD1/SD2	HRV Triangular Index	TINN
Control Group n= 31 Resting Non Linear Domain HRV						
Mean	20.58	37.36	78.4	0.4479	0.2025	283.9
SD	1.822	22.67	33.45	0.1254	0.04593	175.6
Exercise Group n=31 Resting Non Linear Domain HRV						
Mean	21.39	50.71	97.21	0.5068	0.2071	297.9
SD	1.706	33.71	53.64	0.133	0.05335	155.9
Comparison t test for equality of means						
t- test	-1.799	-1.829	-1.656	1.793	-0.369	-0.333
P Value at 60 DF	0.077	0.072	0.103	0.078	0.713	0.740
***Significance**	NS	NS	NS	NS	NS	NS

***Significance at p value <0.05.**

On comparison of Time domain HRV (reflects parasympathetic activity) on resting position in Non exercise Control Group and Exercise Group it was observed that No. of RR interval (heart rate) was significantly less ($p<0.001$), Maximum R-R($p<0.05$), Minimum R-R($p<0.05$) RR-interval whereas Mean($p<0.001$), Median ($p<0.001$), Mode $p<0.001$) were significantly increased means low heart rate and increased parasympathetic activity ($P>.05$) in exercise group than non exercise group. Otherwise in other studied variables of time domain of HRV there was no significant difference. (Table 3)

Table 3
Effect of Sports on Resting Time Domain HRV.

S. N0.	No of RR interval	Maximum RR	Minimum RR	Max/Min RR	Range	Mean
Control Group N= 31 Resting Time Domain HRV						
Mean	**388.7**	**991.5**	**621.2**	**1.605**	**370.4**	**782.7**
SD	**55.59**	**229.3**	**80.06**	**0.3343**	**210.3**	**115.1**
Exercise Group N=31 Resting Time Domain HRV						
Mean	**339.3**	**1115**	**693.5**	**1.676**	**421.5**	**904.3**
SD	**56.36**	**188.8**	**160.4**	**0.4206**	**190.1**	**150.6**
Comparison of Control and Exercise Group						
t- test	**3.478**	**-2.314**	**-2.246**	**-.732**	**-1.004**	**-3.572**
p value df=60	**0.001**	**0.024**	**0.028**	**0.467**	**0.320**	**0.001**
***Significance**	**S**	**S**	**S**	**NS**	**NS**	**S**

***Significance at p value <0.05**

Resting Frequency Domain HRV(reflects sympathetic & parasympathetic activity) showed that none of variable studied in frequency domain of HRV in Non exercise Control Group and Exercise Group was found significant (p>0.05). (Table 4).

Table 4
Resting Frequency Domain HRV.

S. No.	VLF (% Power)	LF (% Power)	HF (% Power)	Total Power (% Power)	LF/HF Ratio	VLF/LF Ratio
Control Group N=31 Resting Time Domain HRV						
Mean	26.57	33.55	39.88	100	1.539	0.921
SD	15.36	14.35	20.73	0	1.944	0.6853
Exercise Group N=31 Resting Time Domain HRV						
Mean	25.51	31.55	42.94	100	1.215	0.9323
SD	14.34	14.36	20.52	0	1.23	0.5409
Comparison of control and Exercise in Resting Time Domain HRV						
t- test	0.281	0.549	-0.584	NC	0.786	-0.072
p value df =60	0.780	0.585	0.561	-	0.435	0.943
***Significance**	NS	NS	NS	-	NS	NS

***Significance at p value <0.05.**

IV. DISCUSSION

This study showed that SBP, DBP and MABP were significantly reduced. Almost similar was revealed by another authors[13-14] that physical activity intensity level between 40-60% VO_2 maximum continued for 20 minutes or longer will be necessary to lower systolic and diastolic blood pressure by 10 mmHg and 5 mmHg respectively, although reduction of 25 mm Hg have been reported and the effect can last from 1-4 hr depending upon the duration and intensity of exercise reasons as it reduces cardiac output, decreases in sympathetic activity, alternation in baro-receptor functioning, increases insulin sensitivity, decreases insulin resistance, nitric oxide is released from the inner portion of vessels walls into circulation with whole body periodic acceleration. It was also reported that aerobic exercise increases the compliance of arteries.[15] Life style choices that lowers blood pressure also includes[16] (a) Lose excess weight; for every 20 pounds you lose; 5-20 mm Hg drop in SBP occurs,(b) Follow a DASH diet; Eat a lower-fat diet rich in vegetables ,fruits and low fat dairy foods;8-14mm Hg drop in SBP occurs,(c)Exercise daily Get 30 minutes of aerobic activity like brisk walk;4-9 mm Hg drop in SBP occurs,(d)Limit sodium; Eat no more than 2400 mg a day (1500 mg) is better ;2-8 mm Hg drop in SBP occurs(e) Limit alcohol; Have no more than 2 drinks a day for men and 1 drink a day for women; 2-4 mm Hg drop in SBP occurs. Knowledge of Exercise induced CHD indicators are important to rule out any contradiction, modification and prescription of exercise as well as appropriate referral[17] includes (A) Hypertensive Exercise response ; Normally SBP progressively increases from 120 mm Hg at rest to 160 to 190 mm Hg during peak intensity exercise. The change in diastolic pressure is generally less than 10 mm Hg. In exercise SBP can rise well above 200 mm Hg , where as diastolic pressure can approach 150 mm Hg. This abnormal hypertensive response provides a significant clue to presence of cardiovascular disease (B)Hypotensive Exercise Response : Faillue of SBP to increase to increase by 20 or 30 mm Hg often results from diminished cardiac reserve and malfunction.(C)Heart Rate Response- A rapid large increase in heart rate early in graded exercise often indicates cardiac dysfunction. Likewise abnormally low exercise heart rates (Bradycardia) in non-endurance trained individuals may reflect unhealthy function of heart's SA Node. Inability of heart rate to increase during graded exercise (chronotropic incompetence), accompanied by extreme fatigue indicates cardiac strain and CHD. An Attenuated maximal exercise heart rate in apparently healthy men and women raises cardiovascular disease mortality risk; specifically, failure to achieve at least 85% of age predicted maximum heart rate during exercise..Our study showed decrease in heart rate and increase in HRV(table 2,3,4) ;another study[18] showed that those patients whose heart rate was above 70 beats per minute had significantly higher incidence of heart attacks, hospital admissions and the need for surgery.HRV is the fluctuations of the activity in brain cardiovascular vasoconstrictor and vasodilatatory centers due to Blood pressure oscillation (baro-reflex modulated),Respiration (para-sympathically mediated via thoracic stretch receptors)Thermoregulation (sympathetically mediated via thermoregulatory peripheral blood flow adjustments),Circadian biorhythm.[6] Heart vitality training and heart rate monitor as aids to athletic performances reported that HRV data can indicate the impact of fatigue due to prior exercise sessions, hydration levels, stress and even the degree of performance anxiety, nervousness or other external stressful influences. [19] Studies[14-19] have shown that it varies within individuals according to size of left ventricle (inherited trait), fitness level, exercise mode (endurance or static training) and skill (economy of exercise). Body position, temperature, humidity, altitude, state of mood, hormonal status, drugs and stimulants all have an effect on heart rate and HRV, as do gender and age. Another study[20] suggested

that heart rate recovery after maximal exercise is associated with acetylcholine receptor M2 (CHRM2) gene polymorphism.

V. CONCLUSIONS

One hour of Sports intervention significantly decreased Resting Systolic, Diastolic and Mean Arterial Blood Pressure, significantly decreased Resting Heart Rate this indicate an economic functioning of heart and increased Heart Rate Variability this indicates a good interplay or modulation between parasympathetic and sympathetic nervous system. Study also reflected Physiological basis of blood pressure and HRV.

CONFLICT

None declared till date.

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