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Effect of Exercise on Cardiovascular System in Yoga Trained and Untrained School Going Children

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Abstract:
Objectives: we evaluated the effect of exercise on cardiovascular parameters in yoga trained and untrained school going children.
Materials and methods: Eighty school going boys of age between 11-15 years were recruited for the study. They were alienated into two groups: 40 yoga trained and 40 yoga untrained based upon yoga training for a minimum of six month period. Cardiovascular parameters like Heart rate, systolic and diastolic blood pressure, mean arterial and rate pressure product were measured before and after exercise training by Modified Harvard Step Test.
Results: Yoga untrained group showed significant increase in baseline heart rate, systolic , diastolic BP,MAP and RPP compared yoga trained group [(70±7.54 Vs 86.1± 13.44,p< 0.000), (113.5±9.36 Vs 119.8±7.24,p <0.001),(75.15± 7.5 Vs 81.1± 6.39,p <0.001),(87.93±6.29 Vs 94±5.35,p< 0.000) and (79.68±12.19 Vs 103± 16.39 ,p< 0.000)].Exercise induced increase in heart rate and blood pressure was blunted in yoga trained group compared to untrained group. Conclusion: Six months of yoga training improves cardiovascular parameters.

Keywords: *Yoga, modifiedHarvard step test, cardiovascular parameters*

1. Introduction

Yoga is timeless pragmatic science evolved over thousands of years dealing with the physical, mental, moral wellbeing of a man as a whole. Yoga is ancient discipline which helps to attain harmonious development of mind, body and leads to positive health [1].Many research studies showed yoga will help in mitigation of chronic fatigue, detoxification of body, improvement in immune system and increase endurance [2]. Yoga believed to aid in prevention and treating many medical conditions like diabetes mellitus, asthma, migraine, arthritis, metabolic syndrome, cardiovascular disease, irritable bowel syndrome, acid peptic disease menopausal symptoms, hypertension and cancer [3-5]. Changing lifestyle, growing demand and competitiveness of modern era resulted in creating great amount of stress and anxiety in the population. Stress is one of the major risk factor to cardiovascular disease. Numerous research studies observed that yoga improves CVD contributory factors like body weight, blood pressure, lipid profile stress significantly [6-9]. However, there is a need of solid evidence to endorse yoga as therapeutic and preventive tool in cardiovascular disease. The present study assessed the role of yoga practice on cardiovascular parameters in school going children.

2. Materials and Methodology

2.1. Sample Selection

Eighty school going children between the age group of 11 to 15 years were enrolled for the study.

- Study Group- 40 boys undertaking regular yoga training 5 days a week were enrolled from Sri AmruthaVidyalaya, Davangere, Karnataka, India
- Control Group- 40 boys of same age who are not trained in yoga were enrolled from other schools of Davangere, Karnataka, India.

Study population included the students of age 11-15years, who trained in yoga for minimum of six months in study group and students who never trained in yoga. Students with previous history of sport training, systemic diseases and surgery are excluded from the study. The study was approved from ethics committee. Prior to recruitment, detailed protocol was explained to the students and parents and a written informed consent was obtained from them

2.2. Design of the study

Forty students in the study group undertook yoga training for a minimum duration of six months under the guidance of qualified trainer. Training was held for five days in a week from morning 8am to 9am.Forty students in the control group were selected randomly from other schools. The training session involves of a) warm up exercises b) prayer c) Asanas d) Pranayama e) Meditation and f) Shavasana

Before undertaking the test, all the students were clarified separately regarding the procedure in their local language and consent was obtained prior to the test.

All the following data were recorded and entered into respective proforma

2.2.1. Anthropometric parameters

a) Height in cms b) Weight in kg c) Body Mass Index (BMI) in kg/m^2

2.2.2. Recording of Physiological parameters

1. Pulse Rate: beats per minute (bpm) - Left Radial Artery is partially occluded.
2. Systolic Blood Pressure (SBP)inmmHg:Byusing mercury Sphygmomanometer.
3. Diastolic Blood Pressure (DBP) inmmHg: Byusingmercury Sphygmomanometer. SBP and DBP are recorded in the sitting position by both Palpatory and Auscultatory methods.
4. Pulse Pressure (PP) in mmHg: It is the difference between Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP).
5. Mean Arterial Pressure (MAP) in mmHg: This is calculated by using formula.

MAP = Diastolic Blood Pressure (DBP) + 1/3Pulse Pressure (PP)

6. Rate pressure product (RPP): This is calculated by using formula RPP= (HR x SBP)/100

Exercise induced cardiovascular response: it was determined by Modified Harvard step test, using a platform.

2.3. Modified Harvard Step Test

18 inch step was used for this test.

2.4. Procedure

The subject steps up and down on the platform at a rate of 30 steps per minute (every two seconds) for 5 minutes or up to exhaustion. Exhaustion described as when the subject cannot maintain the stepping rate for 15 per seconds. Starting with one foot (right or left) and using the same foot as the starting "step up" foot throughout the exercise.

The stepping procedure, set with metronome was explained and demonstrated by trained personnel to the children. The maximum heart rate obtained at the end of the test was used to determine the Physical Fitness Index score. Using Stop Watch duration of the exercise was noted down in seconds during each time of the procedure. HR, SBP, DBP, was measured and MAP and RPP was calculated before exercise and at 3 and 10 minutes after the exercise.

2.5. Statistical Analysis

SPSS package 16th version was used for all statistical analysis. The unpaired t test was applied to compare mean differences of the yoga trained and untrained subjects.

a) p Value > 0.05 is considered' not Significant' .
b) p Value < 0.05 is considered 'Significant
c) p Value < 0.001 is considered 'Highly Significant'

2.6. Results

The study was carried out with recruitment of eight students for a period of one year. Forty students were yoga trained and rest was untrained. Baseline characteristics of both the groups were matched. There was a significant difference between trained and untrained

subjects with regard to baseline cardiovascular parameters like HR,SBP,DBP,MAP and RPP [(70±7.54 Vs86.1± 13.44,p,< 0.000), (113.5±9.36 Vs 119.8±7.24,p <0.001),(75.15± 7.5 Vs 81.1± 6.39,p <0.001),(87.93±6.29 Vs 94±5.35,p< 0.000) and (79.68±12.19 Vs 103± 16.39 ,p< 0.000)] respectively

Comparison of Basal reading in trained and untrained group					
Variables	Yoga trained N=40		Yoga untrained N=40		Statistical Analysis unpaired t test df=78
	Mean	Standard Deviation	Mean	Standard Deviation	
HR	70.08	7.54	86.1	13.44	-6.58, P<0.000
SBP	113.5	9.36	119.8	7.24	-3.37, P<0.001
DBP	75.15	7.5	81.1	6.39	-3.82, P<0.001
MAP	87.93	6.29	94	5.35	-4.64, P<0.000
RPP	79.68	12.19	103	16.39	-7.22, P<0.000

Table 1: Comparison of cardiovascular parameters in yoga trained and untrained group

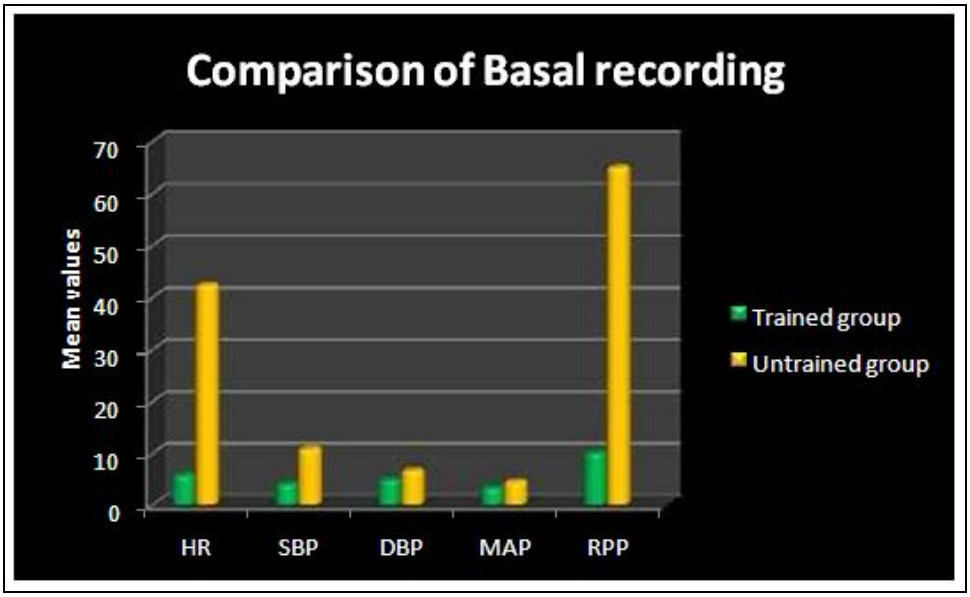

Figure 1: Comparison of Cardiovascular Parameters in Yoga Trained and Untrained Group

All the cardiovascular parameters increased after 3 mins of exercise and decreased after 10 mins of exercise in both the groups.

Yoga trained group N=40						
Variables	Basal reading		3 min after exercise		10 min after exercise	
	Mean	Std Deviation	Mean	Std Deviation	Mean	Std Deviation
HR	70.08	7.54	87.3	17.16	81.7	7.83
SBP	113.5	9.36	119.15	7.83	115.25	8.45
DBP	75.15	7.5	84.35	6.55	79.6	6.46
MAP	87.93	6.29	94.65	5.96	91.48	6.11
RPP	79.68	12.19	104.35	24.01	94.4	21.57

Table 2: Effect of Harvard Step Test in Yoga Trained Group

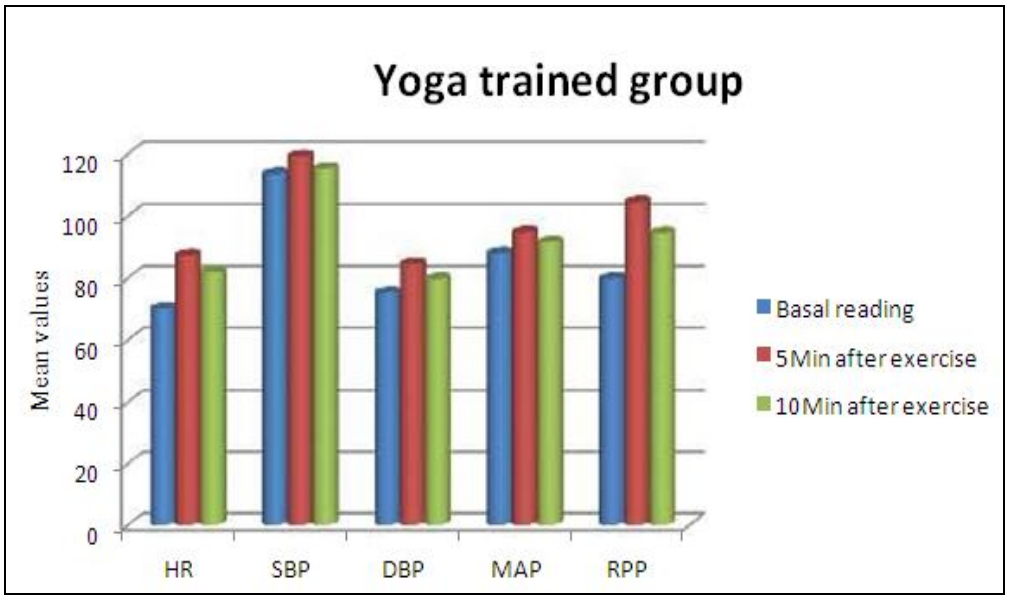

Figure 2: Effect of Harvard step test in yoga trained group

Yoga untrained (N=40)						
Variables	Basal reading		3 min after exercise		10 min after exercise	
	Mean	Std Deviation	Mean	Std Deviation	Mean	Std Deviation
HR	86.1	13.44	126.98	8.92	84.65	13.8
SBP	119.8	7.24	131.65	7.48	120.85	7.54
DBP	81.1	6.39	88.5	6.94	81.9	6.52
MAP	94	5.35	99.28	5.57	94.88	5.63
RPP	103	16.39	167.33	16.83	102.44	18.81

Table 3: Effect of Harvard step test in yoga untrained group

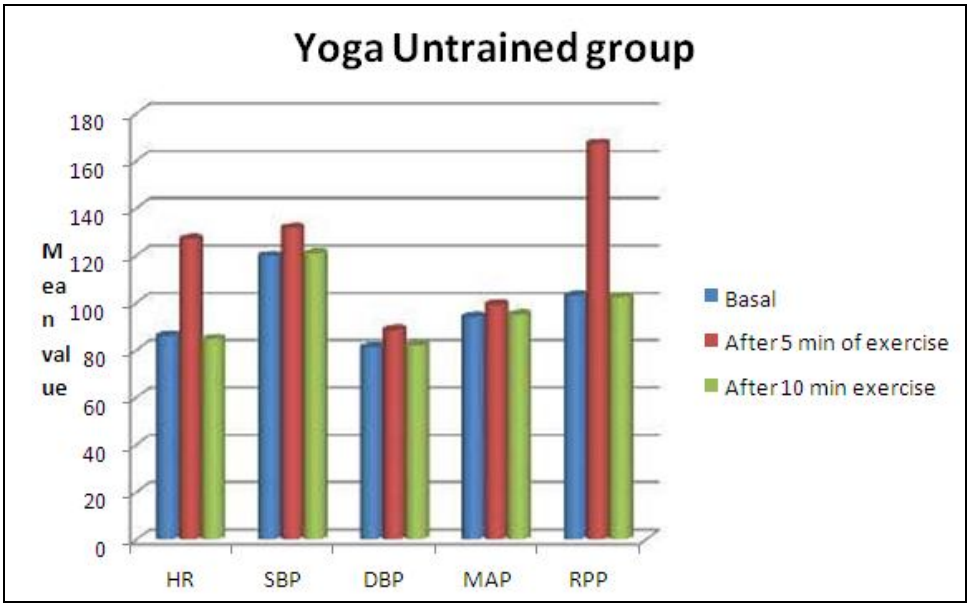

Figure 3: Effect of Harvard step test in yoga untrained group

There is a statistically significant increase in all the parameters i.e.HR, SBP, DBP, MAP and RPP in both yoga trained and yoga untrained groups after 3min of exercise.

Yoga trained group (N=40)						
Variables	Basal reading		3 minutes after exercise		Mean difference	Statistical Analysis Paired t test df=39
	Mean	Standard Deviation	Mean	Standard Deviation		
HR	70.08	7.54	87.3	17.16	-17.23	-7.38, P<0.000
SBP	113.5	9.36	119.15	7.83	-5.65	-9.18, P<0.000
DBP	75.15	7.5	84.35	6.55	-9.20	-8.40, P<0.000
MAP	87.93	6.29	94.65	5.96	-6.72	-8.99, P<0.000
RPP	79.68	12.19	104.35	24.01	-24.67	-8.40, P<0.000

Table No 4: Comparison of cardiovascular parameters before and after 3 mins of exercise in yoga trained group

	Yoga untrained (N=40)					
Variables	Basal reading		3 minutes after exercise		Mean difference	Statistical Analysis Paired t test df=39
	Mean	Standard Deviation	Mean	Standard Deviation		
HR	86.1	13.44	126.98	8.92	-40.88	-21.12, P<0.000
SBP	119.8	7.24	131.65	7.48	-11.85	-12.05, P<0.000
DBP	81.1	6.39	88.5	6.94	-7.40	-8.27, P<0.000
MAP	94	5.35	99.28	5.57	-5.28	-8.35, P<0.000
RPP	103	16.39	167.33	16.83	-64.33	-21.79, P<0.000

Table 5: Comparison of cardiovascular parameters before and after 3mins of exercise in yoga untrained group

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Mean difference of HR (p <0.000), SBP (p<0.000) and RPP (p<0.000) was significantly high in yoga untrained group when compared to yoga trained group. There is no significant difference in DBP and MAP between either group.

Difference between Basal reading & After 3mins exercise					
Variables	Yoga trained N=40		Yoga untrained N=40		Statistical Analysis unpaired t test df=78
	Mean Difference	Std Deviation	Mean Difference	Std Deviation	
HR	17.22	14.76	40.87	12.23	-7.79, P<0.000
SBP	5.56	3.89	11.8	6.23	-5.34, P<0.000
DBP	9.2	6.92	7.4	5.66	1.2, NS
MAP	6.71	4.72	5.28	3.99	1.46, NS
RPP	24.67	18.57	64.32	18.66	-9.52, P<0.000

Table 6: comparison of the difference between basal reading and after 3 mins exercise in Yoga trained and yoga untrained school going boys

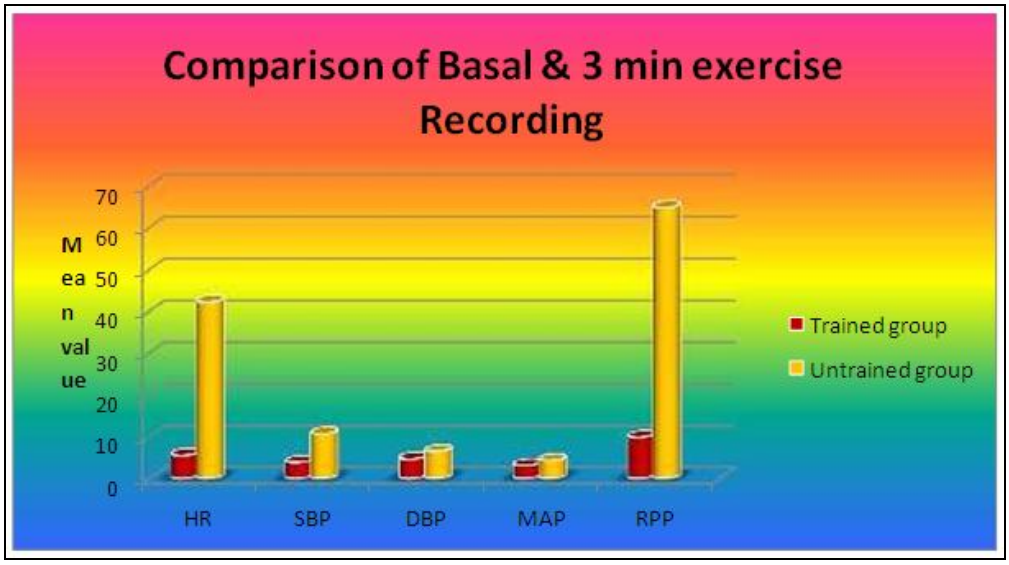

Figure 4: comparison of basal and 3 min after exercise recording in yoga Trained and untrained group

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Significant difference was not observed between the basal reading and after 10 mins of exercise in HR, SBP, DBP, MAP and RPP in yoga trained showing that there is complete recovery within 10 mins of exercise in yoga trained individuals.

Yoga trained group			**N=40**		
Variables	Basal reading		10 mins after exercise		Statistical Analysis Paired t test df=79
	Mean	Standard Deviation	Mean	Standard Deviation	
HR	70.0750	7.53585	71.1500	7.74779	0.63, NS
SBP	113.5000	9.35620	114.3000	8.89310	0.39, NS
DBP	75.1500	7.49547	76.2500	7.44467	0.65, NS
MAP	87.9333	6.29349	88.9333	6.15618	0.72, NS
RPP	79.6805	12.19010	81.4050	11.86469	0.64, NS

Table 7: Comparison of Cardiovascular Parameters before and after 10 mins of Exercise In Yoga Trained Group

Figure 5: Comparison of Cardiovascular Parameters before and after 10 min of Exercise in Yoga Trained Group

There was a statistically significant difference increase in SBP (p<0.00), DBP (p<0.001), MAP (p<0.00) and RPP (p<0.00) after 10 mins of exercise when compared to basal reading in yoga untrained group while the difference in HR was not statistically significant.

Yoga untrained (N=40)					
Variables	Basal reading		10 mins after exercise		Statistical Analysis Paired t test df=79
	Mean	Standard Deviation	Mean	Standard Deviation	
HR	86.1000	13.43703	91.5750	14.16548	1.78, NS
SBP	119.8000	7.24374	129.4000	7.03398	6.01, P<0.000
DBP	81.1000	6.38829	86.2500	6.39210	3.6, P<0.001
MAP	94.0000	5.35466	100.6333	4.75724	5.86, P<0.000
RPP	103.0025	16.39022	118.4935	19.08152	3.89, P<0.000

Table 8: Comparison of Cardiovascular Parameters before and after 10 mins of Exercise in Yoga Untrained Group

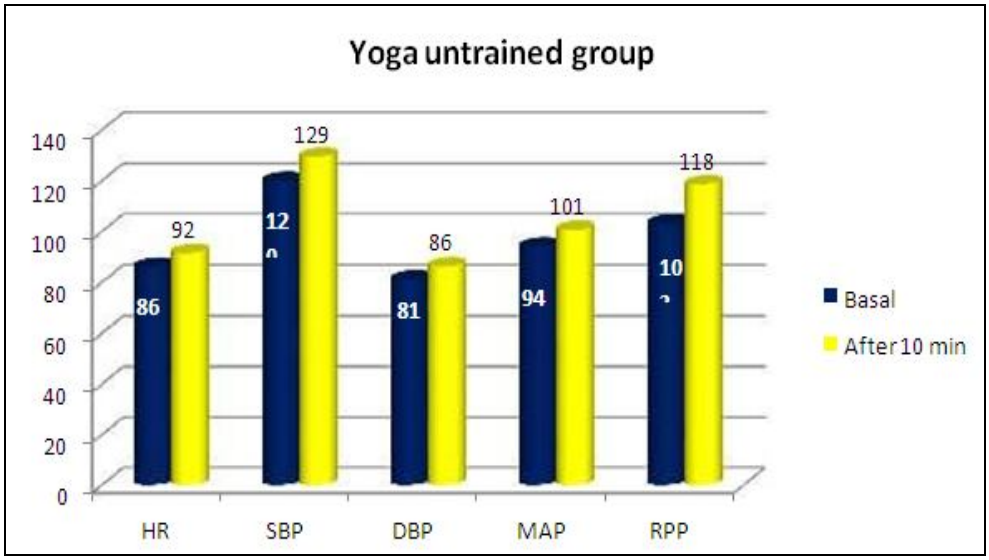

Figure 6: Comparison of Cardiovascular Parameters before and After 10 min of Exercise in Yoga Untrained Group

3. Discussion

Our study observed the cardiovascular changes seen on long term exposure to yoga training (> 6mnths). Yoga training showed a statistically significant decrease in cardiovascular parameters like HR, SBP, DBP, MAP and RPP when compared to yoga untrained group. Our study was supported by a study showing that long duration yoga training affects hypothalamus and brings about decrease in the systolic and diastolic BP through its influence on cardiac centre and vasomotor centre, which results decrease in sympathetic tone and peripheral resistance [10].Madanmohan et al. studied the effect of shavasan and savitri pranayama in trained subjects (yoga training > 1 year) and found significant decrease in oxygen utilization ,diastolic blood pressure, and heart rate[11].Another study by KavirajaUdupa, Madanmohan et al. showed a decrease in HR in yoga trained individual [12].This changes can be attributed to modulation of autonomic activity with parasympathetic predominance and relatively reduced sympathetic activity. This autonomic tone in yoga is mediated through modification of breathing patterns which triggers various central and autonomic mechanisms as well as mechanical and hemodynamic adjustments causing both tonic and phasic changes in cardiovascular functioning.

3.1. Effect of exercise on yoga trained individuals

Exercise produced a marked increase in HR and blood pressure in both yoga trained and yoga untrained groups. However, in the yoga trained group the exercise induced increase in HR was less marked when compared to untrained group. Similarly increase in SBP produced by the exercise was less marked in the yoga trained group. The increase in RPP following the exercise was also less marked in the yoga group as compared to other group. There was no significant difference between the cardiovascular parameters before and after 10 minutes of exercise showing there in complete recovery in these parameters in yoga trained group within 10 minutes of exercise. While yoga untrained group showed a statistically significant difference in SBP, DBP, MAP and RPP. While significant

difference in HR in the group before and after 10 minutes of exercise was not observed. Showing that there is only recovery of HR in yoga untrained while the other parameters did not recover within 10 minutes.

3.1.1. Heart Rate

In our study, yoga training for a period of 6 months produced a significant reduction in basal heart rate. Exercise induced increase in heart rate is significantly lower in yoga trained group. There is progressive recovery of heart rate in yoga trained and yoga untrained during the post exercise period (after 10 minutes). Our study was consistent with the study by Harinath K, Malhotra AS, et al. which showed an increase in HR after exercise which was lower after three months of yoga training [13]. Another study by IndlaDevasena et al. showed that HR and BP significantly decreased after 6 months yoga training [14].Yoga training blunts the sympathetic response to exercise and prolongs the period between successive pacemaker action potentials and results in a decrease in the firing rate.

3.1.2. BP

Our study after 6 months of yoga training, there is significant reduction in basal SBP and basal DBP. There is no significant change in DBP or MAP after exercise between yoga trained and untrained group. Progressive recovery in SBP and DBP to basal values is significantly faster after yoga training.

Our study is consistent with the study done by Bera TK, Gore MM, Oak JP[16]. Another study by Bera and Rajapurkar showed that yoga training results in significant improvement in cardiovascular endurance and anaerobic threshold [17].Muralidhara & Ranganathan reported an improvement in cardiac recovery index on Harvard step test after 10 week yoga training program [18].Another study showed that exercise produced a significant increase in HR, RPP,DoPsystolic pressure and a significant decrease in diastolic blood pressure. Yoga training for a period of two months, changes in these parameters due to exercise was significantly reduced.

Yoga training for a period of 6 months blunts the sympathetic response to exercise and prolongs the period between successive pacemaker action potentials and results in a decrease in the firing rate.23Also practice of yoga caused lowering of the basal heart rate leading to the prolongation of diastolic filling. Under these circumstances, the cardiac output rises through an increase in the stroke volume (use of Frank-Starling mechanism), rather than, by an increase in heart rate [19].Hence there is only mild increase in SBP as a result of exercise. Since the exercise given is of mild-moderate type, there is no significant change in DBP and MAP after exercise between yoga trained and untrained group.

3.1.3. RPP

The O2 consumption by the heart is determined primarily by the intramyocardial tension, the contractile state of the myocardium and the heart rate. The rate pressure product correlates best with the myocardial O2 consumption and is therefore the critical one in defining the response of coronary circulation to myocardial metabolic demands [20].

Present study showed a decreased basal RPP in yoga trained group. Also exercise induced changes in RPP was significantly less and there is significant recovery of RPP in yoga trained group during the post exercise period. The decrease in RPP after yoga training in this study suggests milder cardiovascular response and increased cardiac efficiency since the minute work is the same but the myocardial O2 consumption is lower.

Madanmohan et al. have demonstrated that two months of yoga training decreases basal heart rate, blood pressure, rate-pressure product (RPP = heart rate x systolic blood pressure / 100) [21].

In conclusion, the basal readings of all the cardiovascular parameters like HR, SBP, DBP, MAP, RPP was significantly lower in yoga trained group. These findings suggest shift in autonomic nervous equilibrium towards parasympathetic dominance due to yoga training. Exercise induced changes in HR, SBP, MAP, RPP are significantly lower in post yoga training as compared to pre-yoga training, suggesting better cardiovascular adjustments to exercise after yoga training. Before yoga untrained, only HR returned to pre exercise basal value within 10 minutes. But after yoga training in addition to HR, DBP, SBP, RPP and MAP also returned to their pre exercise basal values at the end of 10 min post exercise period. This suggests faster recovery from exercise after yoga training. Hence, we recommend that yoga training should be introduced as a compulsory discipline in the schools.

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