EFFECT OF YOGA AND PHYSICAL EXERCISE ON RESTING CARDIO-VASCULAR AND CARDIO-VASCULAR AUTONOMIC FUNCTION PARAMETERS: A COMPARISON

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Abstracts:

Objective: Autonomic nervous system plays an important role in the regulation of the cardiovascular system both in ensuring optimal function during various activities in healthy individuals and also in mediating several of the manifestations of cardiac diseases. Research studies have demonstrated that yoga and physical exercise can modulate cardiovascular autonomic functions. Hence, the current study was designed to assess and compare the effect of yoga and physical exercise on resting cardiovascular and cardiovascular autonomic functions.

Methods: 200 healthy volunteers (146 M; 54 F) from age group (17-26) years were included in the study. They were divided into two groups. Gr A Yoga group (n=100) practiced some yoga exercises including Asanas, Pranayam & relaxation techniques daily one hour for 3 months. While Gr B Physical exercise group (n=100) practiced slow walk, calisthenic exercise & stretching exercises daily 1 hour for 3 months. Following parameters were recorded at start & end of the study. Resting cardiovascular parameters including resting heart rate (HR), Blood pressure (SBP, DBP), pulse pressure (PP), mean arterial pressure (MAP), rate pressure product (RPP) & double product (DoP). The autonomic function tests to measure the parasympathetic reactivity were deep breathing test (DBT), lying to standing test (LST) and valsalva ratio (VR). For sympathetic reactivity hand grip test (HGT) and cold pressure test (CPT) were performed.

Result: Yoga group showed significant reduction in heart rate ($p<0.01$), SBP ($p<.05$), MAP, RPP & DoP ($p<.01$), while exercise group showed only decreasing trend. Heart rate response to deep breathing (E: I ratio) increased significantly after yoga training while all other autonomic function tests to measure the parasympathetic reactivity did not change significantly after yoga and physical exercise training ($P>0.05$). In Isometric handgrip test (IHG test) rise in SBP (ΔSBP) was not significantly altered after 3 months of yoga and exercise training whereas rise in DBP (ΔDBP) was significantly decreased in response to IHG test in both groups. Range/response (Δ) of systolic blood pressure and diastolic blood pressure during cold pressor test (CPT) was found to be significantly reduced after yoga training whereas study did not show any marked change in both ΔSBP and ΔDBP during cold pressor test (CPT) after three months of physical training.

Conclusion: The present data provide more evidence to support the beneficial effect of Yoga and physical exercise training on cardiovascular autonomic function variables in healthy volunteers.

Key Words: Yoga, Physical Exercise, deep breathing test (DBT), lying to standing test (LST), valsalva ratio (VR), hand grip test (HGT), cold pressure test (CPT) .

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Introduction:

The autonomic nervous system helps to control arterial pressure, gastrointestinal motility and secretion, urinary bladder emptying, sweating, body temperature and many other activities, some are controlled almost entirely and some only partially. It is well known that physical training and yoga results in favourable cardiovascular changes on variables such as heart rate and blood pressure as both sympathetic and parasympathetic nervous systems undergo changes with regular physical training. [(1)]

Yoga is an ancient philosophic system that originated in India whose main objective is the development of the union of mind and body through exercise, respiration and meditation in order to achieve physical and mental well being [(2-3)]

The most popular branch of yoga is Hatha Yoga, which consists of a combination of postural exercises (Asanas), relaxation and voluntary breathing exercise (Pranayamas).

All over the world, Hatha Yoga has gained popularity as an alternative form of physical activity since it offers a different experience when compared to traditional physical exercise training and is less strenuous and more enjoyable.[4]

The comparative study on the effect of regular practice of yoga and physical exercise on resting cardiovascular parameters, cardio-vascular autonomic function parameters, is important to better understand its effects on healthy individuals and to provide the basis for the possible use of yoga techniques as alternative therapy.

Material and Method:

This study was conducted on 200 healthy students and volunteers between age of 17-26 years of either sex (M146: F54) from various colleges and yoga centres.

Table-1 Details of Yogic Practices

ASANAS
(A) Standing
1. Ardhakatichakrasana (lateral arc pose) 2. Padahastasana (forward bend pose)
(B) Sitting
Ardhamatsyendrasana (half-spinal twist pose) Pschimottanasana (back stretch pose)
(C) Lying on stomach (prone)
1. Makarasana (crocodile pose) 2. Bhujangasana (cobra pose) 3. Shalabhasanas (locust pose) 4. Dhanurasana (bow pose)
(D) Lying on back (supine)
1. Utthanpadasana (straight leg raising) 2. Ardhahalasana (plough pose) 3. Pavanmuktasana (wind relieving pose) 4. Setubandhasana (bridge pose)
(E) Deep Relaxation in Shavasana (Corpse Pose)
(F) Pranayama (Breathing Practices)
1. Kapalbhati Pranayama 2. Anulom-VilomPranayama (alternate nostril breathing) 3. Bhramari (honeybee sound during expiration)

Subjects included in the study were non alcoholic, non smokers, not taking any type of medication and were having similar dietary habits. Subjects involved in heavy physical exercise and previous experience of yoga training, history of any major medical illness and major surgery were not included in the present study.

Subjects were divided in 2 groups: the yoga group (n=100) (M78:F22) allocated to practice yoga for 3 months and the exercise group (n=100) (M68:F32) allocated to practice physical exercise for 3 months.

The volunteers and students were briefed about the outcome of study and a written consent was obtained from them.

Yoga Group: - Yoga group was given yogic training for 1 hour under the guidance of qualified yoga instructor for 3 months regularly. The yogic schedule includes – asanas (postural exercise), relaxation techniques and pranayma (breathing exercise).

Asanas were performed for 40 min. duration. Each subject performed every asana 3 times. The asanas were followed by a meditation/ deep relaxation technique in shavasana (corpse posture) for 5 min. & pranayama (breathing exercise) were performed in the last 15 minutes. The set of asanas & pranayama included in the course are listed in Table -1

The physical exercise group: - This group was given physical exercise training for 1 hour under the guidance of physical exercise instructor. This 1 hour session was divided into 4 stages: warm up (10 min.) calisthenics (30 min.) cool down (5min.) & stretching (15 min.).

In warm up stage – subjects performed stretching & low energetic demand aerobic exercise such as slow walk & brisk walk followed by jogging & running (somewhat hard intensity). Warm up followed by calisthenics exercise – like jumping jacks, lunges, sit-ups, crunches, push-ups, squat, flutter kick, mule kick.

Cool down stage (5 min.) includes slow jogging & walking for 5 min. (to decrease body temp. / sweating).

Lastly stretching exercise was done for 15 minutes. These include- neck stretch, upper back stretch, triceps stretch, chest & biceps stretch, quadriceps stretch, calf stretch, butterfly stretch, hamstring stretch, lower back stretch, back extension stretch.

Parameters:-

First anthropometric characteristics (body weight, height, and BMI) were evaluated using an anthropometric scale. (Table-2)

Table-2 Anthropometric measurements in yoga and physical exercise group

Parameter	Yoga Group		Physical Exercise Group	
	Pre	Post	Pre	Post
Height (m)	1.69±0.07	1.69±.07	1.69±0.09	1.69±.09
Weight (Kg)	60.63±8.91	60.29±8.61	59.36±5.96	58.3±5.69
BMI (Kg/m^2)	21.24±2.72	21.07±2.58	20.82±1.97	20.39±1.91

Then before starting the training & after end of 3 months following parameters were measured.

Resting cardiovascular parameters: After 10 minutes of supine rest, arterial blood pressure (BP) was recorded using a standard mercury column sphygmomanometer and stethoscope. The auscultatory method was employed. Clear sharp, tapping sound heard on lowering the mercury column was taken as SBP and disappearance of the Korotkoff sounds was taken as diastolic blood pressure (DBP).

Simultaneously ECG was recorded by a portable ECG machine, RMS VESTA 101 (RMS Recorders & Medicare Systems, Chandigarh). Heart rate (HR) was measured using an electrocardiograph (ECG) rhythm strip on limb lead II and calculated by dividing 1500 by the number of small squares between two R waves in the ECG tracing.

Pulse pressure (PP = SBP - DBP), mean pressure (MP = DBP + PP/3), rate pressure product [RPP = (HR × SBP)/100] and double product (Do P = HR × MP/100) were calculated for each recording. Three BP and HR recordings at 2-minute intervals were taken and the lowest of these values was included for the present study.

Autonomic function test:

To measure the parasympathetic activity, deep breathing test (DBT), lying to standing test (LST), valsalva ratio (VR) and for sympathetic activity hand grip test (HGT) and cold pressure test (CPT) were performed following the procedures described by Banister and Mathias (1992).[5] All these test employed in the study were simple, reliable and non-invasive.

i) Deep breathing test (DBT): The test was performed in supine position. Subject was asked to lie down comfortably with ECG leads attached to ECG machine till his heart rate was stabilized. Then he was asked to breathe deeply at a rate of 6 breaths per minute, allowing 5 sec each for inspiration and expiration, by counting "IN-2-3-4-5-OUT-2-3-4-5" hand signal were also given to maintain the rate and timing of the breathing. Along with deep breathing ECG recording was also done in IInd limb lead. It was explained that breathing should be smooth, slow and deep.

The parasympathetic activity (heart responses to deep breathing) was measured by calculating E : I (Expiration : Inspiration) ratio.

E : I ratio = average of maximum R-R interval during expiration / average of minimum R-R interval during inspiration.

ii) Lying to standing test (LST): Before the test was performed, the subject was allowed to lie down for 5 min in supine position. ECG leads were connected for recording of lead II ECG. The subject was instructed to stand within 3 seconds from lying position.

30:15 R-R ratio was calculated as the ratio of longest R-R interval around 30th beat and shortest R-R interval around 15th beat from the ECG recording.

iii) Valsalva ratio (VR): For valsalva maneuver subject was allowed to sit in erect posture in a chair with a rubber clip over the nose. ECG leads were connected and he was asked to blow out or to expire forcefully in rubber tube of mercury manometer and to create a pressure of 40 mm Hg and maintain it for 15 sec. Simultaneously an ECG was recorded during VM and 30 sec after finishing it in limb lead II. From the ECG recording, Valsalva ratio was calculated using the formula -

Valsalva ratio = longest R-R interval after maneuver / shortest R-R interval during maneuver.

The following tests were done to assess sympathetic reactivity.

i) Hand grip test (HGT): The maximum voluntary contraction (average of three measurements) was obtained using a handgrip dynamometer then the

subjects was asked to grip the dynamometer with their dominant hand at 30% of their maximum voluntary capacity for 5 minutes in sitting position. During the test procedure BP was recorded at every minute with the help of sphygmomanometer on the non- exercising arm. The rise in diastolic BP at the point just before the release of handgrip was taken as the index of response to HGT.

ii) Cold pressure test (CPT): The subject was asked to immerse his hand in cold water at 4-60C up to the wrist joint for 2 minutes. After 2 minutes subject was allowed to remove the hand. Simultaneously BP was recorded on other arm before starting of the test and towards the end of the test. Increase in systolic and diastolic blood pressure from the baseline value (average of two values) to maximal value, known as the range or response (Δ), was obtained.

Analysis of data

Data obtained for various parameters were subjected to statistical analysis using the Microsoft Excel and OpenEpi software (version 2.3.1). One-way ANOVA and appropriate post hoc test (Bonferroni multiple comparisons procedure) was used to study the changes within the group over the period of time and for inter group comparison. A p value of <0.05 was considered statistically significant.

Observation and Result:

On comparing pre and post training data yoga group shows significant (p<0.01) reduction in resting heart rate. Although decreasing heart rate was also observed in physical exercise group but statically it was not significant. (Table-3)

Both the group shows reduction in systolic and diastolic blood pressure but only in yoga group significant reduction (p<0.05) in systolic blood pressure was observed.

Yoga group also shows significant reduction (p<0.01) in MAP, RPP and DoP, while exercise group shows only decreasing trend (p>0.05).

Table-3 Cardio-vascular changes in Yoga and Physical exercise groups.

Parameter	Yoga Group		Physical Exercise Group	
	Pre	Post	Pre	Post
Heart Rate (beats/min)	77.69±8.57	73.38±5.52**	76.89±6.89	75.48±6.3
SBP (mmHg)	124.39±7.6	121.26±6.79*	125.83±8.7	123.77±8.7
DBP (mmHg)	76.04±6.7	73.62±5.3	77.5±8.62	76.26±6.19
PP (mmHg)	48.35±9.4	47.64±8.17	48.33±11.26	47.51±9.95
MAP (mmHg)	92.16±5.48	89.5±4.46**	93.61±6.83	92.1±5.4
RPP (units)	96.69±12.65	89±8.54**	96.74±11.01	93.32±9.28
DoP (units)	71.66±9.56	65.70±6.22**	71.92±7.97	69.43±6.28

*P<.05 on comparing pre and post.
** P<.01 on comparing pre and post

Table- 4 Changes in Parasympathetic activity in Yoga and Physical exercise groups.

Parameter	Yoga Group		Physical Exercise Group	
	Pre	Post	Pre	Post
E: I ratio (DBT)	1.42±0.16	1.49±0.19*	1.4±0.15	1.42±0.15
30:15 ratio (LST)	1.53±.19	1.55±0.2	1.51±0.19	1.53±0.2
VR	1.69±0.29	1.77±0.26	1.68±0.3	1.67±0.26

*P<.05 on comparing pre and post yoga group

Yoga training resulted into significant increase in E: I ratio (heart rate response to deep breathing) while 30:15 ratio during LST and valsalva ratio (VR) during VM did not change significantly after the yoga training (P>0.05). On comparing pre and post training data physical training shows insignificant change in E: I ratio, 30:15 ratio and valsalva ratio (P>0.05). Although increasing trend was observed in E: I ratio, 30:15 ratio but statically it was not significant.

Isometric handgrip test (IHG test) increased the systolic blood pressure (SBP) but this rise in SBP (ΔSBP) was not significantly altered after yoga and physical training whereas rise in DBP (ΔDBP) was significantly decreased in both groups in response to IHG test (P<.01) .

Table- 5 Changes in Sympathetic activity in Yoga and Physical exercise groups

Parameter	Yoga Group		Physical Exercise Group	
	Pre	Post	Pre	Post
ΔSBP (HGT)	22.32 ±7.1	20.22 ±6.1	21.16± 6.24	20.18± 6.54
ΔDBP (HGT)	19.98 ±7.28	14.46 ±4.45 **	18.44± 6.15	15.66± 4.98**
ΔSBP (CPT)	16.73 ±5.45	12.98 ±4.4* *	16.58± 4.77	15.08± 5.15
ΔDBP (CPT)	12.86 ±4.75	8.8±3 .19**	12.24± 3.75	10.9±4 .18

**P<.01 on comparing pre and post.

In yoga group range/response (Δ) of systolic blood pressure during cold pressor test (CPT) was found to be significantly reduced from 16.73±5.45 mmHg to 12.98±4.4 mm Hg (P<0.01) and diastolic blood pressure from 12.86±4.75 mmHg to 8.8±3.19 mm Hg (P<0.01) but physical exercise group did not show any significant change in both ΔSBP and ΔDBP during cold pressor test (CPT) after three months of training.

Discussion:

Yoga training showed significant reduction in heart rate and it is attributed to increased vagal tone and decreased sympathetic activity. [6,7] Decreased sympathetic activity in turn reduces catecholamine secretion and also leads to vasodilation leading to improvement in peripheral circulation. It is also observed that regular yogic practices reduce basal metabolic rate and resting oxygen consumption.[8] All these may be responsible for reduction in resting heart rate.

RPP and Do P are indirect measures of cardiac oxygen consumption and work done by the heart. In post training analysis of both Yoga and Exercise group there was a fall in cardio- vascular parameters SBP, DBP, MAP, RPP and DoP but SBP, MAP, RPP and DoP was significantly reduced in Yoga group only. This may be understood as being a result of more relaxed state of mind leading to decrease in sympathetic tone coupled with a reduced load on heart as illustrated by RPP and DoP.

The result of our study is in line with the results of Harinath K et al [9] who had observed insignificant difference in the mean HR, SBP, DBP, and MAP after 3 months of follow-up (p >0.05) in physical exercise group. Similar findings of resting cardiovascular parameters value after 3 months of physical training are presented by other authors [10,11] who did not show any significant reduction in SBP and DBP.

Present study showed a significant (P<.05) increase in heart rate response to deep breathing (E: I ratio). Normally, in adults the difference in heart rate varies from 10-15 and a value less than 10 is regarded as abnormal. E: I ratio decreases with increasing age (Bannister R et al, 1992).[5]

A significant rise in E: I ratio after yoga indicates an increase in vagal activity, as the change in heart rate during breathing is mainly due to the change in vagal activity (Ganong WF, 2001).[12] Our finding corroborate with the observations of Pal GK et al (2004) [13] and Mourya M et al (2009). [14]

30:15 ratio and valsalva ratio (VR) indicate intact baroreceptors mediated increase or decrease in heart rate in response to sudden standing from lying down position and Valsalva maneuver respectively so these tests are markers of parasympathetic reactivity and baroreflex function.

In our study the 30:15 ratio and valsalva ratio (VR) did not show any change after 3 months of yoga training although increasing trend was observed in these parameters. This may be due to the shorter duration of training schedule, which was not adequate enough to cause changes in the sensitivity of baroreceptors to affect these parameters. Similar result was also shown by Pal GK et al (2004) [13] and Khanam et al (1996) [15] for VR and Sahoo et al (2010) [16] for 30:15 ratio.

The findings related to E : I ratio, VR and 30:15 (parasympathetic reactivity parameters) in physical exercise group in the present study are similar to that Sharma RK et al [17] in that no significant change was observed in parasympathetic reactivity parameters after physical training.

Isometric handgrip test (IHG test) provides pressor stimuli to cardiovascular system through efferent sympathetic pathways with a resultant increase in HR and BP (Bannister R et al, 1992).[11] Normally, IHG test increases DBP by 16 mm Hg or more and a rise of 10 mm Hg or less indicates abnormal cardiovascular reflex regulation (Bannister R et al, 1992). [11] In our subjects after yoga and physical training, rise in DBP (ΔDBP) was significantly decreased in response to IHG test but rise in SBP (ΔSBP) was not significantly altered in response to IHG test.

Our result is in agreement with the Sharma RK et al [17] who observed that physical training of even fifteen days duration significantly decrease the diastolic blood pressure response to HGT. Previous studies on young trained athletes have also shown a lower sympathetic and hemodynamic response to the isometric exercise and this was accompanied by improved cardiac performance[18] Girish et al [19] showed that trained subjects have attenuated response in HR, SBP and DBP to isometric handgrip contractions when compared to untrained controls and were associated with a corresponding change in sympathovagal balance, so this study confirmed the previous reports which showed that young trained subjects have a lower sympathetic and hemodynamic response to the isometric exercise in comparison to before training response.

After yoga training change in SBP and DBP (ΔSBP and ΔDBP) during cold pressor test was found to be significantly reduced ($P<0.01$). This shows that practice of Yoga is well-demonstrated to reduce the physical effects of stress on the body. Madanmohan et al (2002)[20] and Sharma G et al (2009) [21] studied modulation of CPT-induced stress by shavasana wherein they found a significant reduction in BP. This reduction was explained on the basis of an increase in parasympathetic tone and reduction in sympathetic tone.

Result did not show any marked change in ΔSBP, ΔDBP in CPT after three months of physical training. Insignificant decrease in CPT-induced rise in SBP and DBP in physical exercise group is in agreement with Bond V t al [22] who found no association between physical activity and blood pressure reactivity to the cold pressor test in African Americans who were engaged in different levels of physical activity.

Conclusion:

The present study shows that three months yoga training produces a significant improvement in parasympathetic functions baroreceptor reactivity and decrease in sympathetic response to stress as compared to physical training which produces an improvement in autonomic functions by decreasing sympathetic response to stress.

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