Study on the effect of physical exercise on autonomic functions in healthy volunteers

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Abstract: *Research studies have demonstrated that physical exercise can modulate autonomic functions. Hence, the current study was designed to assess the effect of physical exercise on autonomic functions. 100 healthy volunteers (M68:F32) from age group (17-26) years were included in the study. They practiced some slow walk, calisthenic & stretching exercises daily 1 hour for 3 months. 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. All parameters were recorded at start & end of the study. After physical exercise training no significant difference was observed in E: I ratio, 30:15 ratio and valsalva ratio (P>0.05). In Isometric handgrip test (IHG test) rise in SBP (ΔSBP) was not significantly altered after training but the rise in diastolic BP in response to the test was significantly decreased from 18.44±6.15 mmHg to 15.66±4.98 mm Hg (P<0.01). Study did not show any marked change in both ΔSBP and ΔDBP during cold pressor test (CPT) after three months of physical training. The present data provide more evidence to support the beneficial effect of physical exercise training on autonomic function variables in healthy volunteers.*

Key Words: *physical exercise, Autonomic functions, DBT, E: I ratio, VR, HGT, CPT.*

1. INTRODUCTION:

Physical activity, exercises are known to improve one's overall performance. The benefits of exercise have been known since antiquity. Marcus Cicero, around 65 BC, stated: "It is exercise alone that supports the spirits, and keeps the mind in vigor."

Physical activity has been defined as any bodily movement produced by skeletal muscle contractions that result in energy expenditure. Exercise can be defined as a subset of physical activity that is planned, structured, repetitive, and purposeful in the sense that improvement or maintenance of physical fitness is the objective.

Regular indulgence in physical exercises is known to affect the cardiorespiratory status and autonomic functions of the individual (1,2). Regular physical training causes a decrease in sympathetic tone and an increase in parasympathetic tone (3, 4, 5).

The effect of regular physical exercise on autonomic functions is important to better understand its effects on healthy individuals and to provide the basis for the possible use of physical exercise as alternative therapy.

In this respect the present study evaluated the effect of physical exercise on Autonomic function test.

2. MATERIAL AND METHOD:

This study was conducted on 100 healthy students and volunteers between age of 17-26 years of either sex (M68:F32) from Dr. S.N. Medical College and other academic colleges. 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 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.

Subjects were 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-1)

Table-1 Anthropometric measurements

Parameter	Pre	Post
Height (m)	1.69±0.09	1.69±.09
Weight (Kg)	59.36±5.96	58.3±5.69
BMI (Kg/m^2)	20.82±1.97	20.39±1.91

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

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 (6). 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 4-6^{0}C 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

Paired t test was used to compare the data. P value <0.05 was considered significant.

3. OBSERVATION AND RESULT:

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.

. **Table-2 Parasympathetic activity before and after physical exercise training**

Parameter	Pre	Post
E: I ratio (DBT)	1.4±0.15	1.42±0.15
30:15 ratio (LST)	1.51±0.19	1.53±0.2
VR	1.68±0.3	1.67±0.26

Table-3 Sympathetic activity before and after physical exercise training

Parameter	Pre	Post
ΔSBP (HGT)	21.16±6.24	20.18±6.54
ΔDBP (HGT)	18.44±6.15	15.66±4.98**
ΔSBP (CPT)	16.58±4.77	15.08±5.15
ΔDBP (CPT)	12.24±3.75	10.9±4.18

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

Isometric handgrip test (IHG test) increased the blood pressure (BP). Rise in SBP (ΔSBP) was not significantly altered after training but the rise in diastolic BP in response to isometric handgrip was significantly decreased from 18.44±6.15 mmHg to 15.66±4.98 mm Hg (P<0.01).

Although rise in SBP (ΔSBP) and diastolic BP (ΔDBP) decreased in response to CPT after Physical training but result did not show any significant change in both ΔSBP and ΔDBP during cold pressor test (CPT) after three months of physical training.

4. DISCUSSION:

Present study showed insignificant (P>.05) increase in heart rate response to deep breathing (E: I ratio) and to sudden standing from lying down position (30:15 ratio).

Rise in E: I ratio indicates an increase in vagal activity, as the change in heart rate during breathing is mainly due to the change in vagal activity (7).

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 training although increasing trend was observed in these parameters. This observation raises a question as how long a training schedule results in changes in PNS reactivity? It is hard to answer this question at this stage, but it has been seen that sympathetic reactivity changes appear earlier than parasympathetic reactivity changes (8).

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 (2) 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 (6). In our subjects, IHG test increased the mean DBP by 18.44±6.15 mm Hg before physical training. After training, rise in DBP (ΔDBP) was significantly decreased to 15.66±4.98 mmHg in response to IHG test. This reduction can be explained on the basis of an increase in parasympathetic tone and reduction in sympathetic tone.

Our result is in agreement with the Sharma RK et al (2) 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 (9). Girish et al (10) 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.

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 (11) 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.

5. CONCLUSION:

The present study shows that 3 months of physical training produces an improvement in autonomic functions by decreasing sympathetic response to stress.

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