

# Effect of long-term yoga training on autonomic function among the healthy adults

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## ABSTRACT

**Background:** Autonomic dysfunction is one of the major complications in noncommunicable diseases, and there are studies to prove yoga practice improves cardiac autonomic function. So, this present study was done to compare the autonomic functions among yoga practitioners and nonyoga practitioners. **Methods:** This cross-sectional comparative study was initiated among 68 healthy volunteers of both sexes, after recruiting them based on inclusion and exclusion criteria in the age group of 17-30 yrs. The autonomic reactivity tests like resting heart rate, response of heart rate to standing, Valsalva maneuver, and response of heart rate to deep breathing, response of BP to standing, and sustained hand-grip were done. **Results:** In the autonomic reactivity test, resting heart rate ( $80.92 \pm 11.76$  vs  $69.24 \pm 10.64$ ) and sustained handgrip ( $16.30 \pm 4.53$  vs  $10.20 \pm 3.67$ ) significantly decreased ( $P < 0.05$ ) in the participants of the yoga group compared to control group. Deep breathing test, Valsalva maneuver, 30:15 ratio in lying to standing, and BP response to standing test did not show any significant difference between the groups ( $P > 0.05$ ). **Conclusion:** The present study revealed diminished sympathetic activity and improved parasympathetic activity among the regular yoga practicing participants. It can be practiced regularly to reduce stress and prevent lifestyle-associated disorders in the future.

**Keywords:** Autonomic function, sympathetic and parasympathetic reactivity test, yoga

## Introduction

Stress is body's reaction to the challenges when imposed above the capacity of an individual. Every human being in this dynamic, technologically advanced, and challenging environment is constantly exposed to stress.<sup>[1,2]</sup> Stress is necessary for life as acute stresses improve one's performance by increasing sympathetic discharge provided it occurs for a short period.<sup>[3]</sup> The autonomic nervous system plays a major part in preparing the human body

to adapt to the constant environmental changes and stress by correcting the sensory, visceral, motor, and neuro-endocrine functions.<sup>[4]</sup> Thus, imbalance in the autonomic nervous system with sympathetic overactivity gives rise to hypertension, arrhythmias, and metabolic dysfunction.<sup>[5,6]</sup> It is known that cardiovascular diseases are the foremost cause of morbidity and mortality in developed as well as developing countries.<sup>[7]</sup> The contribution of modifiable risk factors leading to cardiovascular diseases is high and as interventions for those risk factors require considerable economic investments, further affordable interventions are in need at this hour. Exercise is one known method through which the neural, local, and hormonal mechanisms of cardiovascular function can be efficiently managed.<sup>[8]</sup> Yoga stands superior to other forms of exercise as it comprises asanas (posture),

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pranayama (breathing techniques), and meditation. Yoga is the slow nonexertional aerobic practice<sup>[9]</sup> and individuals with chronic debilitating illnesses, such as arthritis, chronic low back pain, heart failure, can also practice yoga without any harm.<sup>[10-12]</sup> Besides, yoga does not require high-end equipment but will warrant consistent commitment towards its practice. Yoga with factually supported interventions that are almost available to everyone, maybe uniquely beneficial for individuals looking for ways to improve their mental and physical health.<sup>[13,14]</sup> Many previous studies have shown positive findings on the outcome of regular yoga practices,<sup>[6,15]</sup> and a majority of these studies have shown the short-term effect of various yogic techniques in a healthy population and in various disease conditions. However, there are only a few studies available on long-term effects (over the years of regular) practice of yoga; hence, this study was undertaken to evaluate the autonomic functions among individuals practicing yoga regularly as their curriculum and compare it with individuals who do not practice yoga.

## Materials and Methods

### Study design

This cross-sectional comparative study was conducted among 68 healthy volunteers of both sexes in the age group of 17–30 yrs. The study was commenced after obtaining ethical clearance from the host institution [IEC: CSP-MED/15/AUG/24/01]. The detailed procedure of the study was explained, and informed consent was acquired from the volunteers.

### Selection criteria

Regular yoga practicing volunteers (Table: 1 for yoga training protocol) were selected from the nearby academic yoga medical college. Healthy participants who do not practice yoga and also any physical activity were selected as a control. Participants with a history of any acute illness, who were athletes or practicing any other physical activity, with endocrine or metabolic disorders, and surgery in recent past years were excluded. After recruiting the volunteers, the procedures of autonomic function test (AFT) were explained to the participants. The participants were asked to come with an empty stomach for the assessment. A detailed questionnaire was administered to get the details of the medical, personal history, and history of physical activity and yoga training. Anthropometric measurements like height, weight were taken. BMI was calculated, and recordings of AFT were done in the morning.

### Outcome measurement

#### Autonomic function test (AFT)

To record the autonomic function test, CANWIN instrument was used, and Ewing's protocol was followed, and the following sympathetic and parasympathetic tests were conducted.<sup>[16]</sup>

#### Parasympathetic reactivity tests

i. **Resting heart rate:** To evaluate this, participants should be given with initial 10 min of rest in the supine position. After

which ECG is recorded continuously for 5 min to assess the heart rate.

- ii. **Expiration-Inspiration Ratio (E: I ratio):** It is the ratio of lengthiest R-R interval during expiration to the smallest R-R interval during inspiration. The subject takes in a deep and steady breath such that respiratory rate is 6 per min.
- iii. **30:15 ratio:** It is the ratio of R-R interval corresponding to the 30<sup>th</sup> and 15<sup>th</sup> heartbeat upon standing from the supine position.
- iv. **Valsalva maneuver:** The subjects are requested to blow into a tube to hold the mercury level at 40 mmHg for 15 sec. Initially, ECG is recorded at rest and during the consequent 40 heartbeats following the maneuver.

#### Sympathetic reactivity tests

- i. **Blood pressure (BP) response to standing:** The blood pressure of the participants is recorded in a lying position after 10 min of rest. Then, they are requested to stand up for 3 min where blood pressure is recorded immediately after standing and 2 min after active standing. This is done to assess orthostatic intolerance caused by a change in posture.
- ii. **Isometric handgrip (IHG) exercise:** This exercise is done using a Hand Grip Dynamometer (INCO, Ambala, India), before the start of exercise blood pressure is recorded. This maneuver is done by making the participants hold the dynamometer in the dominant hand and ask them to give a maximum pull to the clutch. Out of three succeeding trials, the supreme value is taken as the maximum voluntary contraction (MVC). So, from this 30% of the MVC value is used for holding the handgrip steadily for 3 min. Both systolic and diastolic blood pressure is documented for every single minute on nonexercising arm while doing the maneuver. The reaction to handgrip is observed as the greatest increase in SBP and DBP, and this is taken as an index.

#### Statistical analysis

Statistical analysis was done using software R version. Comparison between the groups was done using independent student "t" test. The values are expressed as mean  $\pm$  SD, and  $P < 0.05$  was taken for statistical significance.

## Result

There was no difference in anthropometry between the participants in the control and yoga group [Table 2]. In the autonomic reactivity test, sympathetic reactivity in HGT ( $16.30 \pm 4.53$  vs  $10.20 \pm 3.67$ ) and resting heart rate ( $80.92 \pm 11.76$  vs  $69.24 \pm 10.64$ ) significantly decreased ( $P < 0.05$ ) in the participants of the yoga group compared to the control group [Table: 3]. BP response to standing, Valsalva maneuver, and 30:15 ratio in lying to standing tes not showed any significant difference between the groups. More than 1 year of yoga practice participants showed decreased sympathetic reactivity in HGT ( $12.48 \pm 4.2$  vs  $9.87 \pm 3.18$ ) and resting heart rate ( $71.72 \pm 9.46$  vs  $64.18 \pm 10.30$ ) significantly ( $P < 0.05$ ) compared to the participants with  $< 1$  year of yoga practice [Table:4].

## Discussion

The results of this study showed that the resting HR and Handgrip test parameter were significantly lower in the participants practicing yoga compared to the control group participants, and the results were consistent with previous findings.<sup>[17,18]</sup> The changes in yoga practitioners maybe because of the domination of the parasympathetic nervous system over the sympathetic system. Yoga practice reduces anxiety levels and minimizes the sympathetic hyperactivity induced by stress.<sup>[19-21]</sup> The reduction in sympathetic activity causes decreased catecholamine secretion.<sup>[22]</sup> This improves peripheral circulation by increasing the peripheral vascular dilatation resulting in reduced DBP.<sup>[23]</sup> A Study done by Madanmohan *et al.*<sup>[24]</sup> showed a substantial decrease in resting oxygen consumption and basal metabolic rate seen among the trained subjects with shavasana and savitri pranayama. All these elements will decline load on the heart prompting to decrease in heart rate thereby a decrease in cardiac output and systolic blood pressure.

The study results of the Handgrip test parameter were lower among participants practicing yoga, and it was consistent with other studies done by Jyotsana *et al.*<sup>[21]</sup> and Khanam *et al.*<sup>[25]</sup> Activation of the sympathetic nervous system exists under conditions of strain due to either physical or mental cause. Handgrip exercise is also noted to raise blood pressure and heart rate. Yoga practice triggers activation of the parasympathetic system and declines the activity of the sympathetic nervous system, these may be likely reasons for less increase in BP in yoga practitioners with Handgrip test.<sup>[26]</sup> Progressive attenuation of the sympatho-adrenal and renin-angiotensin activity is observed with yogic practice. Yogic practice, through the restoration of baroreceptor sensitivity, caused a significant reduction in the blood pressure of patients who participated in yoga exercises.<sup>[27]</sup> These variations in autonomic nervous system activity are brought about by the conditioning effects of Yoga. These effects involve the limbic system and higher areas of the central nervous system.<sup>[28]</sup>

There were no differences in deep breathing test (DBT), BP response to standing, Valsalva maneuver, and 30:15 ratio in lying to standing test values between the participants practicing yoga and the control group subjects. These findings may be attributed to less duration of the period of training, which was not adequate enough to cause changes in the sensitivity of baroreceptors and intrathoracic stretch receptors to affect Valsalva ratio, and it is consistent with the results of the study done by Anupkumar Dadarao Dhanvijay *et al.*<sup>[29]</sup>

In this study, significant results are observed in Resting HR, HGT among those doing yoga practice for more than 1 year. This could be due to the capability of the subjects to achieve a state of profound psychosomatic relaxation. Telles *et al.*<sup>[30]</sup> mentioned that slow breathing in pranayama exercises upgraded the autonomic nervous system and expanded the enactment of the parasympathetic system.

Previous research on yoga has only shown favorable results after introducing yoga for a shorter period of time and practicing one or more of the yoga components, such as asanas, pranayama, or

**Table 1: Details of the yoga protocols performed by the participants**

Yoga practices	Duration
1. Joint exercises	5 min
2. Surya namaskar (5 rounds)	5 min
3. Asanas	30 min
Tadasana	
Artha chakrasana	
Padahasthasana	
Vajrasana	
Gomukhasana	
Bujankhasana	
Shalabhasana	
Dhanurasana	
4. Pranayama	15 min
Nadi sudhi	
Kapalabhati	
Bhastrika	
Sheetali	
5.Om Chanting	5 min

**Table 2: Anthropometry of the participants in the control and yoga group**

Anthropometric variables	Control Group n=35	Yoga group n=33	P
Age (yr)	18.80±1.52	20.28±2.84	0.86
Sex (M/F)	19/16	15/18	0.24
Height (cm)	162.78±10.90	168.79±11.85	0.46
Weight (kg)	53.31±13.20	58.20±9.28	0.18
BMI (Kg/cm <sup>2</sup> )	20.13±3.65	21.76±4.62	0.83

**Table 3: Comparison of autonomic function test between participants in control and yoga group**

Autonomic function test	Control n=35	Yoga n=33	P
Resting HR (bpm)	80.92±11.76	69.24±10.64	0.04
DBT (bpm)	1.47±0.79	1.76±0.25	0.06
30:15 ratio (bpm)	1.13±0.26	1.27±0.28	0.21
VR (bpm)	1.56±0.33	1.81±0.12	0.09
HGT (mmHg)	16.30±4.5310	10.20±3.67	0.02
BP response to Standing (mmHg)	6.30±0.86	8.42±1.68	0.08

**Table 4: Comparison of autonomic function test based on the duration of yoga practice**

Autonomic function test	< 1 yr n=20	> 1 yr n=13	P
Resting HR (bpm)	71.72±9.46	64.18±10.30	0.05
DBT (bpm)	1.23±0.49	1.38±0.25	0.4
30:15 ratio (bpm)	1.34±0.14	1.38±0.29	0.12
VR (bpm)	1.33±0.73	1.52±0.64	0.5
HGT (mmHg)	12.48±4.29	9.87±3.18	0.03
BP response to standing	10.58±0.52	8.57±0.80	0.09

meditation.<sup>[31]</sup> The results of this study prove the value of the consistent practice of all aspects of yoga in young age groups who have chosen yoga as their academic curriculum.

Overall, regular and long-term practice of yoga could be an ideal way for lifestyle modification, and family care physicians can advise adapting any kind of yoga practices on long-term basis for the effective management of lifestyle diseases in the future for high-risk patients. In addition, it can be recommended for the patient who seeks supports for psychosomatic disorders for an integrative approach. The affirmative findings of the yoga practice towards the betterment of physical and mental health make yoga complementary in medical practice for the prevention of lifestyle diseases.

## Conclusion

Regular long-term yoga training showed significant effects which streamline autonomic functions that help to prevent lifestyle diseases and their complications. So, it can be used as evidence-based practice by the education and health department for the promotion of yoga as not only a part of the curriculum and also part of their regular habits.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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## Conflicts of interest

There are no conflicts of interest.

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