Int J Pharm Bio Sci 2017 Apr ; 8(2): (P) 71-76

Original Research Article **Physiology**

International Journal of Pharma and Bio Sciences

ISSN 0975-6299

EFFECT OF YOGIC RELAXING ASANS AND PRANAYAMS ON HEART RATE VARIABILITY AND PERCEIVED STRESS IN HEALTHY YOUNG VOLUNTEERS - A COMPARATIVE STUDY

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ABSTRACT

The present study offers evidence of the cardiovascular relaxation and harmonisation of the cardiac autonomic tone through aspects of yoga such as asan and pranayam. A total of 109 healthy volunteers aged 20-25 years were randomly divided into asan, pranayam and wait-listed group. Yoga training was given 25 min/day for 6 days/week for 6 months, in which Pranayam group received relaxing pranayam, asan group received relaxing asans and third group was wait list control group. Pre and post HRV results of each group were statistically compared by paired 't' test and between the group was compared by One-way ANOVA. Pre-post analysis revealed that High frequency (HF) significantly increased ($p<0.05$) and Low frequency component (LF), LF/HF ratio, PSS significantly decreased ($p<0.05$) in asan and pranayam group but no significant difference was found in control group ($p>0.05$). Inter group comparison analysis by ANOVA revealed that LF, LF/HF ratio, PSS significantly decreased and HF significantly increased in asan and pranayam group as compared to controls. There was no significant difference between asan and pranayam groups.

KEYWORDS: ***Asana, pranayama, HRV, perceived stress, shavasan, salutogenesis***

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Received on: 03-01-2017
Revised and Accepted on 22-02-2017
DOI: http://dx.doi.org/10.22376/ijpbs.2017.8.2.p71-76

INTRODUCTION

Salutogenesis the term introduced by Antonovsky, which focuses primarily on the factors that promote the health rather than the usual focus on risk factors and disease.[1] It is concerned with relationship between health, stress and coping. Undoubtedly, yoga is the best lifestyle ever designed originated from ancient Indian culture promotes health and well being.[2] Yoga harmonizes mind and body and also reduces stress and enhances relaxation, thereby contributing to salutogenesis. Change in the modern lifestyle increases the prevalence of stress induced hypertension in young adult population in recent years. Yoga promotes psychosomatic relaxation reduces the stress and decreases one's perception of stress. Among the eight limbs of Ashtanga Yoga, asans (firm and comfortable postures) and pranayams (slow, deep, conscious, rhythmic breathing) are practiced commonly and also utilised in yoga therapy. Based on limited scientific research, yoga (meditation, asans and pranayam) including relaxation therapy is known to improve cardiovascular autonomic functions and stress. Yoga has a role in prevention, management and rehabilitation in stress induced lifestyle disorders like hypertension.[3-5] Heart rate variability (HRV) is non-invasive and well established physiological parameter used to assess sympathovagal balance, an index of cardiac autonomic function.[14] HRV is quantified in two domains, namely time and frequency. Time domain measures include the assessment of variations, as done in statistics. Time domain analysis is a simple method to quantify overall HRV whereas power spectral analysis provides a means of studying different mechanisms responsible for variability in instantaneous heart rates.[6] Finer aspects of variations may not be appreciated in time domain and hence variations in the instantaneous HR can be assessed spectrally using frequency domain analysis. An RR tachogram is plotted using RR intervals obtained from a 5–10 min recording of lead II electrocardiography (ECG). The RR tachogram is considered as a nonperiodic signal, which is transformed to its frequency spectrum using Fast‑Fourier transformation (FFT) algorithm or autoregressive modelling.[14] The biggest advantage of this complex mathematical transformation is that the distribution of magnitude of variations in different frequency bands corresponds to activity of different physiological systems. Increase in HRV is associated with decreased sympathetic and increased vagal tone influence on the sino atrial (SA) node of heart. Decreased HRV and sympathovagal balance have been reported to be associated with cardiovascular morbidity and mortalities.[7,8] In yoga relaxation techniques, the sympathetic discharge is inhibited and parasympathetic discharge is facilitated. Yoga practices including meditation, relaxation, yoga postures, breathing and integrated practices improves autonomic regulation and enhances vagal dominance as reflected in HRV measures.[8] In a recent study by Ramkumar et al. it was reported that pre-hypertensive patients had decreased HRV values.[10] A combined protocol of asan, pranayam and meditation may increase all HRV measures except low frequency (LF), low frequency and high frequency (HF) ratio (LF/HF) components where decreases provide evidence that yoga practice optimizes autonomic functions with reduction in stress. Punitha et al found that twelve weeks of yoga therapy reduced both systolic pressure (SP) and diastolic pressure (DP) in yoga group. Furthermore, yoga therapy increased the heart rate variability and vagal tone while reducing sympathetic tone in subjects with hypertension.[11] Raghuraj et al reported the comparative effects of kapalabhati and nadi shuddhi thus becoming the first ones to use HRV analysis to differentiate effects of slow and fast pranayams and their effects on the autonomic nervous system (ANS).[12] HRV was used to analyses results of shavasan training in students by Madanmohan et al and this was soon followed by another study discussing the correlation between short-term HRV indices and heart rate, blood pressure indices, pressor reactivity to isometric handgrip in healthy young male subjects.[6,13]

MATERIALS AND METHODS

A prospective comparative Hospital based study was conducted in the Department of Medicine and Centre for Yoga Therapy Education and Research of Sri Balaji Vidyapeeth, Pondicherry. Considering the duration of study and persons visiting in past 2 years, a total number of 120 subjects, aged between 20-25 years were selected through Centre for Yoga Therapy Education and Research (CYTER) in Sri Balaji Vidyapeeth, Pondicherry and informed consent obtained from them. They were randomly divided into 3 groups: Group I received pranayam (pranav, savitri, nadi shuddhi and chandra nadi), Group II received asan (pawanmukthasan, balasan, dharmikasan and shavasan) and group III was wait listed as control. Two subjects dropped out from group I, two from group II and seven from group III. Pranayam and asan techniques were taught to the respective groups for 3 days and they were familiarized with the yoga techniques and made comfortable to the yoga training hall atmosphere. A total of 25 minutes training program was given to each group for 6 days a week for 6 months under our supervision. During this period wait list control group was given study time for group discussion on academic activities. Ethical permission to conduct study was obtained from Institute Human Ethical Committee (IHEC) before commencement of the study.

Yoga training program

Relaxing pranayam training

- Pranav, savitri, nadi shuddhi and chandranadi pranayam were practised in an erect sitting position (vajrasan or sukhasan). Each pranayam technique was practised six times interspersed with short periods of rest. All pranayam technique were characterised by slow, deep, rhythmic inspiration using adham - lower chest breathing, madhyam - middle chest breathing and adhyam - upper chest breathing followed by controlled expiration in the same order (adham-madhyam-adhyam).
- Pranava pranayam is slow, deep and rhythmic breathing where emphasis is placed on making the sound AAA, UUU and MMM while breathing out for duration of two to three times the duration of the inhaled breath. It is a four part technique consisting of adham Pranayam (lower chest breathing with the

sound of AAA), madhyam Pranayam (mid-chest breathing with the sound of UUU), adhyam Pranayam (upper chest breathing with the sound of MMM) and then the union of the earlier three parts in a complete yogic breath known as mahat yoga pranayam with the sound of AAA, UUU and MMM.

- Savitri pranayam is a slow, deep and rhythmic breathing, each cycle having a ratio of 2:1:2:1 between inspiration (purak), held-in breath (kumbhak), expiration (rechak), and held out breath (shunyak) phases of the respiratory cycle. Count of six was used for the inspiration and expiration, with a three count for the retained breaths (6x3x6x3).
- Nadi shuddi pranayam is slow, rhythmic, alternate nostril breathing. One round consisted of inhaling through left nostril, exhaling through right nostril and then repeating the same procedure from right to left nostril.
- Chandranadi pranayam is slow deep breathing with equal duration of inspiration and expiration and performed exclusively through the left nostril.

Relaxing asan training

- Each asan was practiced for three to five minutes with interspersed rest between rounds. Emphasis was placed on moving body parts slowly with conscious breathing in a mindful manner.
- Pawanmuktasan was done from the supine shavasan by bending the right leg at the knee while breathing in and simultaneously lifting head. After catching hold of the knee with the hands, the subject tried to touch their knee to forehead. The position was held for a few seconds and then while breathing out the position was slowly released by lowering the head and simultaneously bringing the foot back to the ground. This was repeated three times and then after a short rest in shavasan was performed on the left side. After a short relation in shavasan the double legged dwipadpawanmuktaasan was done by bending and lifting both knees while breathing in and brought the knees as close to forehead as possible while simultaneously raising their head. This was held for a few seconds and then while breathing out, the head was lowered and simultaneously feet brought back to the ground. This was repeated three times before relaxing in shavasan for a short while.
- Balasan was done from the four footed chatuspadasan by relaxing the elbows to the floor, and placing the chest flat down in between the elbows. Once this position was attained, the head was turned to face to the right side with the subject resting like a baby. They were instructed to breathe deeply in and out three to six times while concentrating the breath into the high lobes and then turn the head to the left and repeat the breathing in and out three to six times before retracing step-by-step back to vajrasan.
- Dharmikasan was performed from vajrasan by slowly bending forward until the forehead touched the floor with nose between both knees. Arms were kept alongside the body with the hands catching hold of the heels and elbows kept on the floor in a relaxed manner. The subjects were asked to concentrate on the point of the forehead touching the floor and visualize anything that they wish to remember well such as study materials etc. When ready they slowly lifted the head on an in breath and came back to the vajrasan.
- Shavasan was performed by the subjects while lying down supine on the ground with head and body in a straight line and arms kept relaxed by the side with palms facing upwards. Feet were brought together and then let to fall away into a 'v' shape with the heels as close together as possible. Conscious relaxation was induced by tensing body parts (spanda) from tow to head with deep inspiration followed by relaxation (nishpanda) of the same parts with prolonged expiration.

Recording of heart rate variability (HRV)

HRV was recorded in research lab, Department of Physiology, MGMCRI. Subjects were explained about the method of recording ECG and were familiarized with the laboratory environment. Recordings were obtained between 8 and 10 AM without any stimulants in pre-recording period. The laboratory temperature was maintained at comfortable level with subdued lighting. Subjects were made in supine position on couch and allowed to relax for 10 min. Lead II ECG and respiration were recorded at the 500 samples per sec by using INCO Polyrite-D for 5 min. R-R interval data were extracted by RMS polyrite software, then HRV was analyzed from R-R interval by Kubios HRV, version 2.0, Department of Physics, University of Kuopio, Finland. HRV data analysis and signal processing followed guidelines defined by "Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology".[14]Time domain components consisted mean HR, mean RR, standard deviation of RR intervals (SDNN), square root of the mean of the sum of the squares of differences between adjacent RR intervals (RMSSD), adjacent RR interval differing more than 50 ms (NN50) and NN50 counts divided by all the RR intervals (pNN50). Frequency domain components consisted very low frequency (VLF) component (0.003 to 0.04 Hz), low-frequency (LF) component (0.04 to 0.15 Hz), and high-frequency (HF) component (0.15 to 0.5 Hz) and LF/HF ratio; Low frequency power in normalized units (nu) (LF nu) = (LF x 100) / (TP–VLF), and similarly HF (nu) was calculated. HF, HF (nu), SDNN, RMSSD, NN50, and pNN50 reflect cardiovagal tone; LF reflects both the sympathetic and parasympathetic tones; VLF component's interpretation is not clear, and it cannot be interpreted using short-term HRV recordings; LF (nu) and HF (nu) represent a relative tone of sympathetic and parasympathetic nervous system (PSNS).

Cohen's Perceived Stress Scale (PSS) questionnaire

Most widely used psychological questionnaire for subject's perception of stress. A 10 item Cohen's PSS questionnaire were used to score feeling and thoughts during last month in this study. All the questions were explained to the subjects and requested to answer. PSS scores were obtained by reversing responses (e.g., 0 = 4, 1 = 3, 2 = 2, 3 = 1 & 4 = 0) to the four positively stated items (items 4, 5, 7, & 8) and then summing across all scale items. A short 4 item scale is made from questions 2, 4, 5 and 10 of the PSS 10 item scale.

STATISTICAL ANALYSIS

Data obtained in our study are tabulated and statistical analysis were done in Microsoft excel 2007, Pre and post training of each group were statistically compared by paired ‘t’ test. The mean of all the groups before and after yoga training were compared by one way ANOVA. The data were presented as Mean ± Standard deviation, P<0.05 was considered as statistical significance.

RESULTS

Data is given in table:1. Pre and post training of each group were statistically compared by paired ‘t’ test. Relaxing pranayam causes significant increase (P<0.05) in RMSSD and HF, (P<0.01) in mean RR, SDNN and pNN50 after training. Relaxing asan causes significant increase (p<0.05) in Mean RR, RMSSD and HF, (P<0.01) in SDNN, (P<0.001) in pNN50 after training. Relaxing pranayam causes significant decrease (P< 0.01) in Mean HR, LF and LF/HF, (P<0.001) in PSS after training. Relaxing asan causes significant decrease (p<0.05) in LF, (P<0.01) in Mean HR, LF/HF and PSS after training. There is no significant difference in control group after training. The mean of all the groups before and after yoga training were compared by one way ANOVA. It was found that there was no significant difference between pranayam, asan and control group before yoga training but there was significant increase (P<0.05) in Mean RR and PSS(P<0.01) in SDNN, RMSSD, pNN50 and HF, significant decrease (P<0.05) in Mean HR, (P<0.01) in LF and (P<0.001) in LF/HF. Moreover we found that there is no significant difference between pranayam and asan group after yoga training.

Table1
Effect of 6 month pranayam and asan training on heart rate variability (HRV) and Perceived Stress Scale (PSS)

Parameters	Pranayam		Asan		Control	
	Pre	Post	Pre	Post	Pre	Post
Mean RR	764.024±79	812.98±65.5$^{**\#}$	773.33±100.39	813.31±68.72$^{*\#}$	770.16±102.86	771.64±97.51
Mean HR	77.88±5.85	74.13±3.65$^{**\#}$	78.62±5.98	73.71±6.38$^{**\#}$	79.54±10.74	77.84±11.54
SDNN	46.53±14.15	54.67±15.06$^{**\#\#}$	47.22±12.66	54.52±13.69$^{**\#\#}$	43.28±16.36	43.93±18.86
RMSSD	37.23±13.26	54.671±15.06$^{*\#\#}$	47.229±12.66	54.53±13.70$^{*\#\#}$	43.29±16.36	43.93±18.86
pNN50	10.52±3.86	12.90±3.86$^{**\#\#}$	10.89±1.58	12.24±2.24$^{***\#\#}$	10.53±4.12	10.25±3.80
LF (ms^2)	446.87±53.95	401.92±46.95$^{**\#\#}$	457.84±54.38	401.76±80.32$^{*\#\#}$	441.97±36.02	458.33±27.89
HF (ms^2)	195.94±70.28	234.07±69.23$^{*\#\#}$	204.84±43.96	229.89±58.79$^{*\#\#}$	211.75±64.67	192.09±61.42
LF/HF	2.49±0.96	1.89±0.63$^{**\#\#\#}$	2.30±0.79	1.86±0.65$^{**\#\#\#}$	2.37±0.94	2.59±0.80
LF (n.u)	69.20±8.14	63.75±7.00$^{**\#\#\#}$	67.84±8.15	63.62±6.57$^{**\#\#\#}$	76.61±8.85	69.95±8.10
HF (n.u)	30.17±8.14	36.25±7.50$^{**\#\#\#}$	32.15±8.15	36.37±6.57$^{**\#\#\#}$	34.70±6.67	30.04±8.15
PSS	24.31±5.13	20.79±3.75$^{***\#}$	23.68±4.24	21.52±2.60$^{**\#}$	23.27±4.52	23.18±5.19

Data are expressed as Mean±SD. *P<0.05, **P<0.01 and ***P<0.001, difference between pre and post training. $^{\#}$P<0.05, $^{\#\#}$P<0.01 and $^{\#\#\#}$P<0.001, difference between pranayam, asan and control by using one-way ANOVA

DISCUSSION

In the present study, after six months of yoga training program, time domain measures such as mean RR, Mean HR, SDNN, RMSSD, pNN50 increased in both the pranayam and asan groups. Frequency domain measures such as HF component increased while LF and LF/HF ratio decreased in both pranayam and asan groups, with no significant changes in control group. This provides evidence that practicing yoga for six months improves cardiac autonomic functions while enhancing sympathovagal balance of the heart. The post training shift of cardiac autonomic tone towards the parasympathetic in both asan and pranayam groups is supported by an earlier review that identified 42 studies with over 85% of them offering some evidence that yoga promotes a reduction in sympathetic activation, enhancement of cardiovagal function, and a shift in ANS balance from primarily sympathetic to parasympathetic.[15] The increase in HRV power in both groups is an important finding that reflects the health promoting benefits of yoga. This assumes significance when we realise that reduced HRV is a predictor of hypertension, development of diabetic neuropathy, cerebrovascular disease, congestive heart failure, and lethal arrhythmic complications after an acute myocardial infarction.[16] Low HRV and baroreflex sensitivity reflect impaired cardiovagal adaptability and suggest excessive sympathetic and/or insufficient parasympathetic tone that are, in turn, strong independent predictors of cardiovascular morbidity and mortality. In contrast, high HRV and baroreflex sensitivity are generally considered to indicate good cardiovagal adaptability and SVB, permitting greater responsivity and sensitivity to changing environmental demands.[15] Sympathetic and vagal output from the brain mainly occurs from the limbic‑hypothalamic‑medullary axis. Vasomotor center and vagal nuclei in the medulla of brain are the sympathetic and parasympathetic outflow nuclei respectively which are controlled by anterior and posterior nuclei of hypothalamus. Pranayam (Slow and deep breathing) through by lung proprioceptors send impulses to limbic‑hypothalamic‑medullary to enhances the vagal tone on heart rate.[17] According to the hypothesis put forward by Jerath and colleagues voluntary slow deep breathing functionally resets autonomic nervous system through stretch-induced inhibitory signals and hyperpolarization currents propagated through both neural and non-neural tissue synchronizing neural elements in heart, lungs, limbic system and cortex.[18] They suggested that the stretching of lung tissue during such inspiration produces inhibitory signals by action of slowly adapting stretch receptors (SARs) and hyperpolarization current by action of fibroblasts. Both the inhibitory impulses and the hyperpolarization currents can synchronize neural elements leading to modulation of nervous system and decreased metabolic activity indicative of a parasympathetic state. Our study gives evidence to support the above hypothesis as in both groups, breathing was done in a conscious manner and with above tidal volume breathing. A recent study reported that pranayama performed with differing ratios of inspiration and expiration produce differential effects on HR and respiratory sinus arrhythmia (RSA).[19] This was attributed to enhanced vagal activity due to conscious changes in higher centers that override the lower respiratory centre in the brain stem. Pranava pranayama produced greatest changes in HR, RSA and expiration to inspiration ratio (E:I). A recent randomized controlled trial (RCT) by Sharma et al compared effects of 12 weeks of thrice weekly training in fast and slow pranayama on perceived stress scale (PSS) and cardiovascular parameters.[20] They reported significant decrease in PSS scores in both groups and attributed it to reduction in stress due to better autonomic tone (higher parasympathetic and lesser sympathetic tone). This may also be due to an internalisation that occurs through the introspective performance of all yoga practices that enables the attainment of a more holistic perspective towards life.[2] This is substantiated by an Agency for Healthcare Research and Quality (AHRQ) report states that “Yoga helped reduce stress” and reductions in perceived stress following yoga are reported to be as effective as therapies such as relaxation, cognitive behavioral therapy and dance therapy.[21] Streeter et al recently proposed a theory to explain the benefits of Yoga practices in diverse, frequently comorbid medical conditions based on the concept that Yoga practices reduce allostatic load in stress response systems such that optimal homeostasis is restored.[22] They hypothesized that Yoga-based practices correct under activity of the parasympathetic nervous system and GABA systems in part through stimulation of the vagus nerves, the main peripheral pathway of the parasympathetic nervous system, and reduce allostatic load. This has been the finding of our study too as both the slow and fast pranayams are seen to improve the cardiac autonomic tome with parasympathetic balance. Khattab et al., have reported that relaxation by yoga after 5 weeks of training is associated with a significant increase of cardiac vagal modulation.[23] In contrast, Chaya et al., reported that subjects who had practiced yoga for a year had higher resting sympathetic activity compared with controls as evidenced by significantly higher LF power, lower HF power and higher LF/HF ratio.[24] Another randomized control trial in Brazil reported significant decreases in LF as well as LF/HF ratio following 4 months of respiratory yoga training.[25]It has been suggested by Bhavanani that knowledge of inexpensive, effective and easily administrable yogic techniques by health professionals will go a long way in helping us achieve the goal of the World Health Organisation to provide “physical, mental, spiritual and social health” for all sections of human society.[26] In the same review it was hypothesised that yoga and other eastern mind-body techniques bring about better neuro-effector communication, improve strength, and enhance optimum functioning of all organ-systems while increasing resistance against stress and diseases with resultant tranquillity, balance, positive attitude and equanimity.[26]

CONCLUSION

Our present study offers evidence that practising yoga such as pranayam and asan causes cardiovascular relaxation and harmonisation of the cardiac autonomic tone. It also aimed to compare the differential effects of asan and pranayam training but found that both pranayam and asan training have similar beneficial effects as compared to a wait-listed control group. The positive changes in HRV and PSS may be attributed to an enhancement of parasympathetic tone and reduction in sympathetic activity with decreased perception of stress. Pranayam is relatively easier to perform and hence the findings of this study give us scope for further research in clinical situations where patients, geriatric population and the physically challenged may not be able to perform the asans but can do the pranayam.

CONFLICT OF INTEREST

Conflict of interest declared none.

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We sincerely thank the above reviewers for peer reviewing the manuscript