INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

A Study on Influence of Yoga on Autonomic Variables on Young Adults

Shashikiran H. C.
Assistant Professor, Department of Pathology, SDM college of Naturopathy and Yogic Sciences, Ujire, Karnataka, India
Shivaprasad Shetty
Professor & Dean, Division of Yoga and Physical Therapeutics, SDM college of Naturopathy and Yogic Sciences, Ujire, Karnataka, India
Prashanth Shetty
Principal /Professor, Department of Natural Therapeutics, SDM college of Naturopathy and Yogic Sciences, Ujire, Karnataka, India
Chethan Kumar R.
M D Scholar, SDM college of Naturopathy and Yogic Sciences, Ujire, Karnataka, India

Abstract:
Background & Objectives: Yoga is an ancient Indian science and an art of living. The beneficial effects of yoga are being studied scientifically in recent times. The present study adopts a systematic approach in comparing the effects of practicing yoga for one and two years with novices on autonomic and respiratory variables.
Materials and Methods: Three groups of 30 healthy volunteers each, of both genders, with ages ranging between 18-22 years were recruited. The subjects of group one (G1) had no experience in yoga while the group two (G2) and group three (G3) had one and two years of experience respectively. Subjects were assessed for Heart Rate, HRV, Blood pressure and respiratory rate at baseline, during deep breathing and isometric hand grip test. Their levels of anxiety along with their performance in a task requiring attention were recorded. The data collected were analyzed using tests for normality and one way ANOVA using SPSS version 20.
Results: One way ANOVA comparing the baseline values for Autonomic and respiratory variables showed G2 and G3 had significantly lower respiratory rates than G1 ($P<0.001$). The blood pressure (both Systolic and Diastolic) were significantly lower in G2 ($P<0.001$, for both comparisons) and G3 ($P<0.001$, for both comparisons) compared to G1. Also, the heart rate was significantly lower in G3 ($P<0.05$) compared both G1 and G2.
Following Isometric Hand grip test there was a significant increase in the heart rate and blood pressure in G1 and G2 ($p<.01$). Similarly, following deep breathing test, there was a significant reduction in heart rate in all three groups ($p<.05$, for all comparisons).
Digit letter substitution task: There was no significant difference across three groups for the net scores recorded following the substitution task ($p>.05$, one way ANOVA).
Conclusion: Practicing Yoga for longer duration has shown to influence autonomic functions positively and induce regulated physiological rest.

Keywords: *Yoga, Heart rate variability (HRV), STAI, Autonomic status, Isometric hand grip*

1. Introduction

Stress is a condition where expectations are genetically programmed, established by prior learning or deduced from circumstances which do not match the current or anticipated perceptions of the internal or external environment. (Goldstein 1990)Socio-economic factors and industrialization along with pollution is a known factor towards causing stress and altered emotions, which carry a definite and well established role in precipitating cardio-vascular events. (Suls and Bunde 2005)Also, the worry intensity is known to prolong stress related physiologic activity and is proportionate to daily somatic complaints. (Verkuil et al. 2012)Autonomic Nervous System [ANS], a part of the peripheral nervous system that controls the visceral system, functioning largely below the level of consciousness, capable of being influenced by the psychological factors and influences the physiological processes happening in the body. The ANS

is capable of regulating the blood pressure, gastro-intestinal responses to food, responses to physical activity, thermoregulation etc., indicate the crucial role of ANS in the maintenance of homeostasis. (Roure et al. 1998)With developing conclusive evidences suggesting the effect of stressors in mediating the HPA axis and altering the autonomic responses, triggering a series of events towards development of various pathologies in the human system, testing Autonomic functions are reliable indicators of understanding homeostasis.

Yoga is an ancient Indian science well known presently all over the world for its potential therapeutic benefits both physical and mental, which commonly includes the practice of physical postures (asanas), breathing practices (pranayama) and meditation (dhyana) practices being practiced in India since thousands of years to attain functional harmony between body and mind. Having a vast evidence of the beneficial role of immediate and short term yoga practices over autonomic functions, anxiety, depression, hypertension and other morbidities of stress, a necessity to understand the regulatory role of yoga in long term practitioners is warranted.

Non-pharmacological therapies play a major role to relieve stress and anxiety of which yoga takes first place compared to pharmacological treatment. (McCorry 2007)Yoga, an ancient Indian science of wellbeing, is one of the many different techniques for achieving relaxation. (Li and Goldsmith 2012)The most central and common aspects of yoga practice today are different bodily postures (asanas) and voluntarily regulated breathing (pranayamas), (Kauts and Sharma 2009)that aims at focusing the mind, achieve relaxation and increase wellness. (Monk-Turner and Turner 2010)Yoga has been reported to provide potential health benefits in anxiety, stress reduction and general well-being. (Ramos-Jiménez et al. 2009)The practice of yoga is now gaining international acceptance for stress-coping skills. Yoga helps to promotes physical and mental health. (Sims 1997)

1.1. Objectives of the Study

1. To evaluate the effects of practicing yoga for longer duration on autonomic and respiratory variables
2. To assess the levels of Autonomic reactivity using Isometric Handgrip test and Deep Breathing test in novices compared experienced yoga practitioners.
3. To assess the levels of Autonomic reactivity on ECG, Respiration and Blood pressure in experienced yoga practitioners as compared to novices.

2. Materials & Methods

2.1. Source of Data

The subjects were selected from the S. D. M. College of Naturopathy & Yogic Sciences, Ujire. The subjects were students of the above mentioned college. Ninety subjects (47 male and 43 female) belonging to three different groups were selected from a population of 102 subjects. They were divided into 3 groups based on their experience of practicing yoga. Each group consisted of 30 subjects. Novices with no experience in yoga (G1) consisted of 17 males and 13 females. Individuals with one year experience in yoga (G2), those with two years' experience in yoga group (G3) were matched for gender to that of G1 and hence consisted of 17 males and 13 females respectively. The study was approved by the Ethical Review Committee. Informed written consent was obtained from all the 90 subjects.

2.1.1. Inclusion Criteria

Students with age ranging from 18 to 22 years, belonging to both the gender were recruited.

1. Novices group: The students having no experience of practicing yoga.
2. The students who have practised yoga for one year and for two years.
3. Subjects who are healthy based on a routine clinical examination.
4. Students who have signed the consent form.

2.1.2. Exclusion Criteria

1. Individuals with medical conditions like:-Cardiovascular disorders, Diabetes mellitus, Bronchial asthma, Endocrinal disorders, Depression, Epilepsy, Psychological disorders.
2. Females during menstrual cycle or Ovulation and any other medical conditions were not included for assessments.

2.1.3. Criteria of Selection

Those residing at the hostels which have a regulated diet and activities as prescribed by the college authorities. Those who voluntarily agreed to participate in the study alone were selected.

2.1.4. Study Design

The present study design is Cross sectional Design based on Onetime Assessment. Here all the subjects, of all the three groups are assessed for autonomic variables and respiration at base line, during deep breathing and isometric hand grip. All the subjects assessed once for psychological assessments.

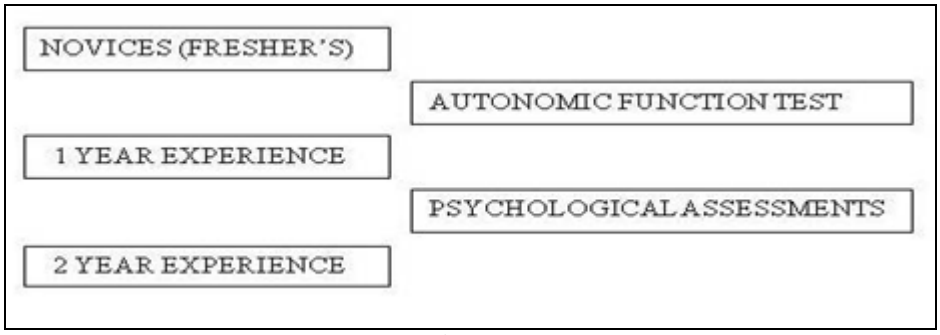

Figure 1

2.2. Assessments

2.2.1. Method of Collection of Data

Onetime assessment of the following variables was done for all the 3 groups.

Autonomic functions were recorded for five minutes at baseline, five minutes during isometric hand grip test and five minutes during deep breathing test in sitting position on the chair.

2.2.2. Autonomic Function Testing

A two channel polygraph (BIOPAC MP150 System, USA) was used for recording ECG and Respiration. EKG was recorded using standard limb lead II configuration. The data recorded were visually inspected off-line and only noise free data was included for analysis. Respiration was recorded using a respiratory transducer placed on the chest over the lower costal margins. The blood pressure was recorded with a sphygmomanometer by auscultation over the right brachial artery.

2.3. Provocation Testing

2.3.1. Isometric Hand Grip Test [IHG]

The instrument consisted of a sphygmomanometer cuff folded on it and taped permanently in position. The cuff was inflated until the column of mercury rose to 30 mm. The patient then squeezed the cuff with the unsupported dominant hand on 3 occasions at intervals of 10 s. The maximum height of the mercury column achieved on each occasion was noted and the grip strength taken as the mean of the second and third readings. The scale on the sphygmomanometer was hidden at all times from the subject. (Downie et al. 1978)

2.3.2. Six Breaths per Minute Test

The subject sits quietly and then breathes deeply and evenly at 6 breaths/min. The maximum and minimum heart rates during each breathing cycle are measured and the mean of the differences during three successive breathing cycles are taken to give the maximum-minimum heart rate. (Ewing et al. 1985)

2.4. Psychological Testing

2.4.1. Spielbergers State Trait Anxiety Inventory (STAI)

To study the impact of Anxiety Neurosis on daily life. It included two different inventories, each having 20 items. The state anxiety inventory determines how the individual feels at a certain moment and under certain conditions and determines how the individual feels irrespective of conditions and circumstances. Inventories have direct and inverted sentences. When scoring 'inverted' sentences expressing positive feelings, those with a weight value of 1 are transformed into 4 and those at the value of 4 are transformed into 1. In direct statements expressing negative feelings, answers scored as 4 indicate a high level of anxiety. In inverted statements, answers scored as 4 indicate low anxiety and those scored as 1 indicate high anxiety. The overall score from both inventories vary between 20 and 80. High scores demonstrate high anxiety levels. Reliability and validity were evaluated and found satisfactory. (Collimore et al. 2008)

2.4.2. Digit Letter Substitution Task

By using this participant has to respond by writing the corresponding letter in a blank space. This makes performance relatively more dependent on memory and complex visual processes and to provide a more specific measure of information processing speed. The key gives the numbers 1 to 9, each paired with a different letter; the test items are printed beneath the key. Participants were required to replace the randomized letters with the appropriate digit indicated by the key. The first 10 items are used as practice items, to ensure that participants understand the test instructions. After completion of these items, participants were instructed to replace the remaining items as quickly as possible. The key and the stimuli were the same for the oral and written versions of the LDST. The number of correct substitutions made in 60 seconds was the dependent variable for both test versions. (van der Elst et al. 2006)

3. Intervention

The techniques include physical practices (kriyas, asanas, a healthy yoga diet), breathing practices with body movements and Pranayama, meditation, devotional sessions, lectures on yoga, stress management and lifestyle change through notional corrections for blissful awareness under all circumstances (action in relaxation). Yoga was taught by qualified yoga teachers.

4. Data Extraction

4.1. Heart Rate Variability

The HRV power spectrum was obtained using Fast Fourier Transform analysis (FFT). The energy in the HRV series of the following specific bands was studied viz. the very low frequency component (0.0-0.05 Hz), low frequency component (0.05-0.15 Hz), and high frequency component (0.15-0.50 Hz). The low frequency and high frequency values are expressed as normalized units. In addition to frequency domain analysis, time domain analysis was also done. The following components of time domain HRV were analyzed: (i) mean RR interval (the mean of the intervals between adjacent QRS complexes or the instantaneous heart rate), (ii) NN50 (the number of interval differences of successive NN intervals greater than 50 ms), and (iii) pNN50 (the proportion derived by dividing NN50 by the total number of NN intervals). Fourier analysis of the R-R interval series was done using the HRV analysis software version 2.1 developed by the Biomedical Signal Analysis Group, University of Kuopio, Finland. (Al Haddad et al. 2010)

4.2. Heart Rate

The R waves from the electrocardiogram are detected, to obtain a point event series of successive R-R intervals, from which the beat to beat heart rate series are computed. The heart rate is obtained based on R-R inter-beat interval analysis. The heart rate in beats per minute (bpm) was obtained by continuously counting the QRS complexes in successive 60 s periods.

4.3. Respiratory Rate (RR)

Respiratory rate (in cycles per minute) was calculated by counting the breath cycles in 60seconds epochs. The readings obtained from the 5 minute data was averaged.

5. Data Analysis

Statistical analysis was done using SPSS (Version20.0) package. A One way ANOVA was used to look at the difference between 3 groups. A paired sample‘t’ test was used to the before and after values of individual groups following the two tasks i.e., Isometric Hand Grip Test and Deep Breathing test.

6. Results

The data were found to be normally distributed across groups ($p>.05$, Shapiro wilk test). Autonomic and respiratory variables: One way ANOVA showed that G2 ($P<0.001$) and G3 ($P<0.001$) had significantly lower respiratory rates than G1. The blood pressure (both Systolic and Diastolic) were significantly lower in G2 ($P<0.001$, for both comparisons) and G3 ($P<0.001$, for both comparisons) compared to G1. Also, the heart rate was significantly lower in G3 ($P<0.05$) compared to G1 and G2. The change in blood pressure (both systolic and Diastolic) following Isometric Hand grip test was significantly higher in G1 compared to G2 and G3 ($p<.001$ for both comparisons). However, the changes on heart rate, respiratory rate and components of heart rate variability spectrum were not significantly different across groups following IHG as well as Deep Breathing test ($p>.05$, for all comparisons).

Within group pre-post comparisons for IHG showed a significant no significant changes for all the variables ($p>.05$). Similarly, the changes following Deep Breathing was also not significant ($p >.05$). The group mean values ± SD for heart rate, respiratory rate; blood pressure (systolic and diastolic) and the components of HRV recorded in all three groups at baseline and after Deep breathing as well as Isometric Hand Grip Test are given in Table 1, 2, 3.

Variable	Group One		
	Base Line	Deep Breathing	Hand Grip
Respiration	13.04±2.51	10.93±2.01	12.53±2.74
Heart Rate	79.14±9.02	78.70±8.26	79.60±9.70
NN50	73.43±55.54	91.00±48.57	79.20±59.25
PNN50	19.33±14.95	23.77±13.23	20.51±15.73
F	67.91±22.13	85.42±12.90	67.35±25.07
HF	32.11±22.12	14.58±12.90	32.65±25.07
LF/HF	4.17±4.95	11.55±11.14	4.49±3.93
SBP			116.87±4.29
DBP			78.40±3.21

Table 1: Scores obtained for Respiratory rate, Heart rate, HRV and Blood pressure of three groups. Values are group Mean ± S.D.

Variable	Group Two		
	Base Line	Deep Breathing	Hand Grip
Respiration	11.49±3.51	8.96±2.17***	11.04±3.13
Heart Rate	76.22±12.95	76.82±11.25	78.71±12.74
NN50	73.73±63.31	87.30±53.78	71.40±65.94
PNN50	21.62±19.76	24.64±16.36	20.41±19.70
LF	68.25±23.37	81.54±20.63	77.44±14.55
HF	31.75±23.37	18.46±20.63	22.56±14.30
LF/HF	4.87±5.19	11.79±10.92	5.64±4.08
SBP			110.13±4.07***
DBP			73.80±3.42***

Table 2: Scores obtained for Respiratory rate, Heart rate, HRV and Blood pressure of three groups. Values are group Mean ± S.D.

Variable	Group Three		
	Base Line	Deep Breathing	Hand Grip
Respiration	11.68±2.59	8.67±2.15***	11.06± 2.46
Heart Rate	71.38±9.39*	73.87±10.03	73.26± 9.68
NN50	80.87±62.41	93.27±54.08	82.90± 59.19
PNN50	23.61±20.00	27.46±18.19	24.08±18.61
LF	53.94±25.07	82.81±18.65	65.01±23.19
HF	46.06±25.07	17.19±18.65	34.99± 23.19
LF/HF	3.47±6.16	11.74±12.68	4.18±5.51
SBP			108.87± 5.45***
DBP			70.67± 3.50***

Table 3: Scores obtained for Respiratory rate, Heart rate, HRV and Blood pressure of three groups. Values are group Mean ± S.D.

One way ANOVA comparing group 2, group 3 with group 1. *p<0.05; **p<0.01; ***p<0.001
G1 – Novices(yoga practice), G2 – one year of yoga practice, G3 – two year of yoga practice
0ne way ANOVA showed that G2 (P<0.001) and G3 (P<0.001) was significantly better than G1 with respect to changes in respiration. Also there was a significant change in G2 and G3 in comparison with G1 with respect to both systolic and diastolic blood pressure. Further, there was a significant change in G3 in comparison with G1 and G2 respect to Heart rate. However there were no significant changes observed in other parameters.
Digit letter substitution task: There was no significant difference across three groups for the net scores recorded following the substitution task (p>.05, one way ANOVA).
Spielbergers State Trait Anxiety Inventory (STAI) showed no difference across three groups (p> .05, One way ANOVA). The group mean values ± SD for STAI, Personality types and Digit Letter Substitution task recorded in all three groups are given in Table 4.

Variables	Group one	Group two	Group three
STAI	47.70±5.78	48.23±7.98	48.13±6.98
LDST	87.67±19.29	90.87±13.23	87.73±21.28

Table 4: Scores obtained for Spielbergers State Trait Anxiety Inventory (STAI), Digit Letter substitution task and of three groups. Values are group mean ± S.D.

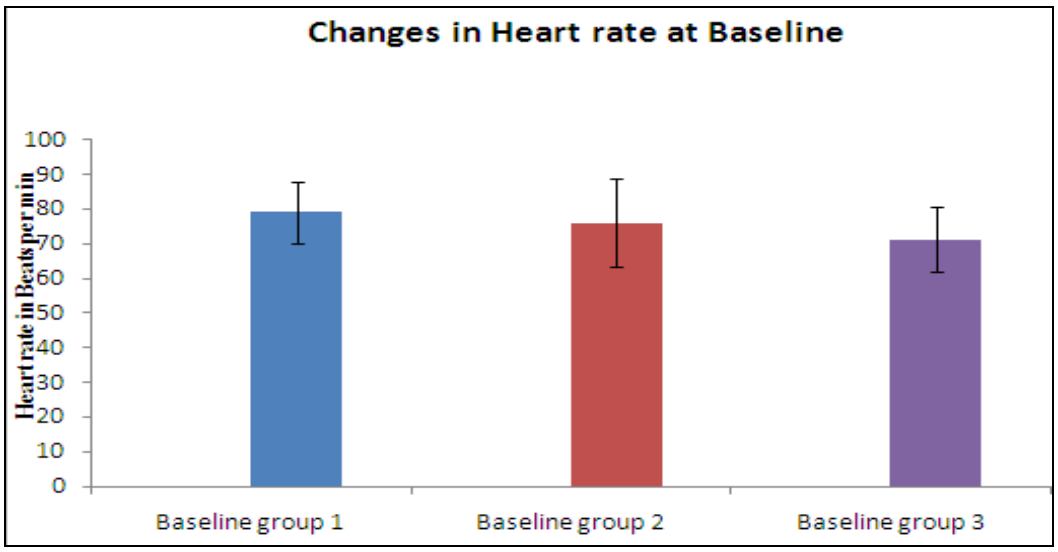

Figure 2: Showing the changes in heart rate between the groups at baseline

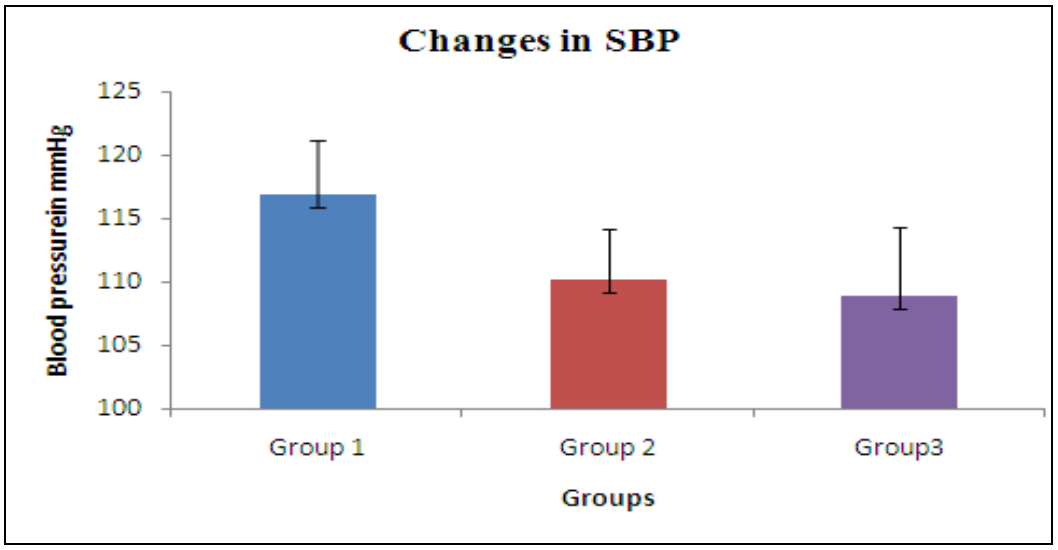

Figure 3: showing the changes in SBP between the groups at Hand grip

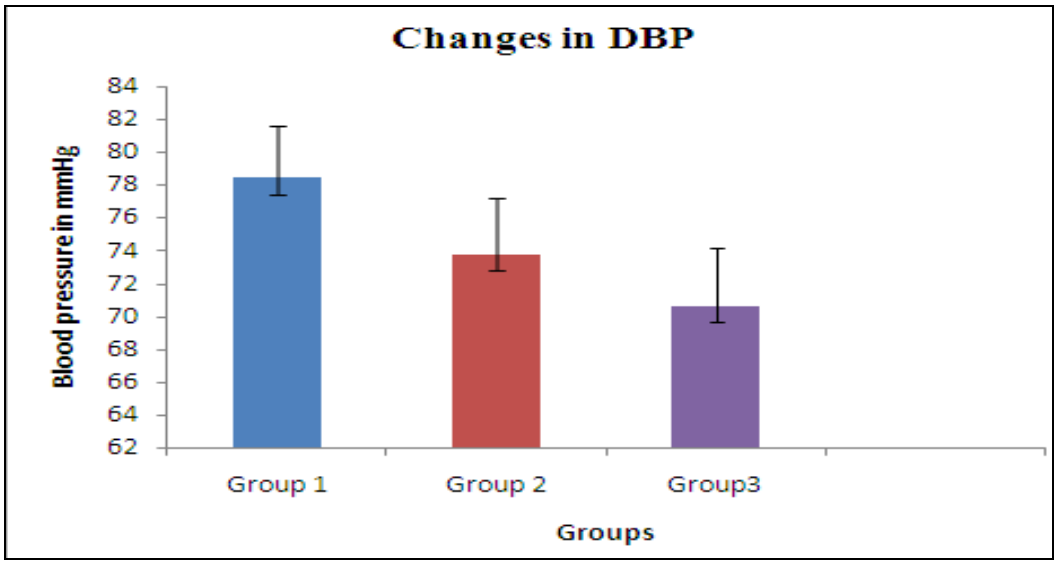

Figure 4: Showing the changes in DBP between the groups at Hand grip

7. Discussion

Practicing Yoga regularly for longer durations has been shown to influence autonomic status positively. When compared to novices, those practicing yoga for one year and a group practicing for two years had significantly lower heart rates. Following an Isometric Hand grip test, the increase in blood pressure (both systolic and diastolic) was higher in Novices compared to other two groups practicing yoga.

Yoga has been used effectively for voluntarily controlling involuntary functions. Studies have shown the possibilities of attaining exceptional feats physiologically following long term practice of Yoga. Perhaps, the ability to bring the electrical activity of the heart to a standstill was the earliest to attract the attention of international scientific community. (Kothari, Bardia, and Gupta 1973)This was followed by series of studies on Transcendental meditation, suggesting that the long-term practitioners were physiologically distinct compared to novices. In an attempt to understand the influence of meditation on the aging process, another study demonstrated that long-term practitioners were younger compared to their chronologically age matched non-practitioners based on visual perceptual sensitivity and blood pressure. (Wallace et al. 1983)The results of the present study related to lower blood pressure appears to be in line with the above findings, but following a provocation task.

The results of the present study are further supported by a recent report which examined the influence of meditation over longer durations.

As a first attempt in meditation research, when assessed using Magnetic Resonance Imaging (MRI), long term meditators demonstrated increased cortical thickness suggesting active neural plasticity. (Lazar et al. 2005)

While attempting to understand the underlying mechanisms for the influence of meditation on autonomic functions, a recent report demonstrated that long term meditation practitioners had higher gray matter density in lower brain stem regions compared to age-matched non meditators. It was inferred that long-term practitioners of would have structural differences in brainstem regions concerned with cardio-respiratory control. It was also speculated that the above mentioned finding might have contributed to some of the cardio-respiratory parasympathetic effects and traits, as well as the cognitive, emotional, and immune-reactive impact reported in several studies of different meditation practices. (Vestergaard-Poulsen et al. 2009)

Lower heart rates in experienced Yoga practitioners can hence be attributed to its influence on the autonomic nervous system through the brain stem region. Also, the relaxation induced by Yoga can reduce physiological arousal. Meditation or relaxation according to yogic scriptures aims at calming the mind, slowing down the breath and relaxing the muscles and this is consistent with the effect of small changes in the psychological state on heart rate, respiratory rate and energy expenditure.

Long term practice of Yoga training includes variety of physical and respiratory manoeuvres which can enhance the respiratory sinus arrhythmia. (Chaya et al. 2006)The decrease in the blood pressure could be due to practice specific breathing practices by the subjects of our present study. The left nostril breathing showed a reduction in systolic blood pressure and mean pressure may be related to a combination of effects such as changes in cardiac output, peripheral vascular resistance and humoral factors. The practice of alternate nostril breathing also decreased both systolic and diastolic blood pressures. (Raghuraj and Telles 2008)Hence, the results of the present study demonstrated that practicing Yoga for longer durations has very strong and positive psycho-physiological implications. Further studies are required to understand these influences most comprehensively.

8. Limitations

In this study, the main limitation is the small sample size with low power significance on HRV. Subjects of our study were the students of professional medical college; it has twice a year, break from the regular yoga practice. It may have profound effect on the present study.

8.1. Directions for Future Research

The same study with more number of subjects can be studied by selecting the subjects from the group of regular yoga practitioners. It is better to identify the biological markers for Yoga. Understanding the molecular basis for the physiological differences observed through integrative cell biology would be the new path to unravel.

9. Conclusion

Practicing yoga regularly for more than one year can reduce the physiological arousal and develops the ability to adapt to a demanding situation.

10. Acknowledgement

The president SDME society, Ujire.

11. References

1. Chaya, M S, A V Kurpad, H R Nagendra, and R Nagarathna. 2006. “The Effect of Long Term Combined Yoga Practice on the Basal Metabolic Rate of Healthy Adults.” BMC complementary and alternative medicine 6: 28.
2. Collimore, Kelsey C., Randi E. McCabe, R. Nicholas Carleton, and Gordon J G Asmundson. 2008. “Media Exposure and Dimensions of Anxiety Sensitivity: Differential Associations with PTSD Symptom Clusters.” Journal of Anxiety Disorders 22: 1021–28.

3. Downie, W W et al. 1978. “The Visual Analogue Scale in the Assessment of Grip Strength.” Annals of the rheumatic diseases 37: 382–84.
4. Van der Elst, Wim, Martin P J van Boxtel, Gerard J P van Breukelen, and Jelle Jolles. 2006. “The Letter Digit Substitution Test: Normative Data for 1,858 Healthy Participants Aged 24-81 from the Maastricht Aging Study (MAAS): Influence of Age, Education, and Sex.” Journal of clinical and experimental neuropsychology 28: 998–1009.
5. Ewing, D. J., C. N. Martyn, R. J. Young, and B. F. Clarke. 1985. “The Value of Cardiovascular Autonomic Function Tests: 10 Years Experience in Diabetes.” Diabetes Care 8: 491–98.
6. Goldstein, David S. 1990. “Neurotransmitters and Stress.” Biofeedback and Self-Regulation 15: 243–71.
7. Al Haddad, Hani et al. 2010. “Effect of Cold or Thermoneutral Water Immersion on Post-Exercise Heart Rate Recovery and Heart Rate Variability Indices.” Autonomic Neuroscience: Basic and Clinical 156: 111–16.
8. Kauts, Amit, and Neelam Sharma. 2009. “Effect of Yoga on Academic Performance in Relation to Stress.” International journal of yoga 2: 39–43.
9. Kothari, L K, A Bardia, and O P Gupta. 1973. “The Yogic Claim of Voluntary Control over the Heart Beat: An Unusual Demonstration.” American heart journal 86: 282–84.
10. Lazar, Sara W et al. 2005. “Meditation Experience Is Associated with Increased Cortical Thickness.” Neuroreport 16: 1893–97.
11. Li, Amber W., and Carroll Ann W Goldsmith. 2012. “The Effects of Yoga on Anxiety and Stress.” Alternative Medicine Review 17: 21–35.
12. McCorry, Laurie Kelly. 2007. “Physiology of the Autonomic Nervous System.” American Journal of Pharmaceutical Education 71.
13. Monk-Turner, Elizabeth, and Charlie Turner. 2010. “Does Yoga Shape Body, Mind and Spiritual Health and Happiness: Differences between Yoga Practitioners and College Students.” International journal of yoga 3: 48–54.
14. Raghuraj, P., and Shirley Telles. 2008. “Immediate Effect of Specific Nostril Manipulating Yoga Breathing Practices on Autonomic and Respiratory Variables.” Applied Psychophysiology Biofeedback 33: 65–75.
15. Ramos-Jiménez, Arnulfo et al. 2009. “Cardiovascular and Metabolic Effects of Intensive Hatha Yoga Training in Middle-Aged and Older Women from Northern Mexico.” International journal of yoga 2: 49–54.
16. Roure, R. et al. 1998. “Autonomic Nervous System Responses Correlate with Mental Rehearsal in Volleyball Training.” European Journal of Applied Physiology and Occupational Physiology 78: 99–108.
17. Sims, J. 1997. “The Evaluation of Stress Management Strategies in General Practice: An Evidence-Led Approach.” The British journal of general practice : the journal of the Royal College of General Practitioners 47: 577–82.
18. Suls, Jerry, and James Bunde. 2005. “Anger, Anxiety, and Depression as Risk Factors for Cardiovascular Disease: The Problems and Implications of Overlapping Affective Dispositions.” Psychological bulletin 131: 260–300.
19. Verkuil, Bart, Jos F. Brosschot, Esther E. Meerman, and Julian F. Thayer. 2012. “Effects of Momentary Assessed Stressful Events and Worry Episodes on Somatic Health Complaints.” Psychology & Health 27: 141–58.
20. Vestergaard-Poulsen, Peter et al. 2009. “Long-Term Meditation Is Associated with Increased Gray Matter Density in the Brain Stem.” Neuroreport 20: 170–74.
21. Wallace, R K et al. 1983. “Systolic Blood Pressure and Long-Term Practice of the Transcendental Meditation and TM-Sidhi Program: Effects of TM on Systolic Blood Pressure.” Psychosomatic medicine 45: 41–46.