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Cardiovascular response to yoga in stressed Manipuri women

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Abstract
Stress exposure activates autonomic nervous system and affects cardiovascular function. Yoga practice stabilizes it. Stress levels were assessed in 50 stressed Manipuri women of 18-45 years using Holmes and Rahe Stress Scale. Electrocardiograph Cardiart 108T/MK was used to record electrocardiographic changes and to determine 30:15 R-R ratio and valsalva ratio (VR), and Hand dynamometer (IMI-2095) to determine blood pressure response to handgrip. Autonomic functions were assessed before and after three months of yoga training. Paired t test and one way ANOVA were used for analysis using statistical software SPSS version 21 of 50 participants, 8(16%) were low to moderately stressed, 32(64%) highly stressed and 12(24%) very highly stressed. Significant reduction was seen in resting heart rate (p=0.000), systolic blood pressure (p=0.000), diastolic blood pressure (p=0.000) and increase in 30:15 R-R ratio (p=0.000) and VR (p=0.000) after yoga training. Yoga provide parasympathetic dominance over sympathetic suggesting improvement in cardiovascular function.

Keywords: stress, cardiovascular function, parasympathetic dominance, yoga therapy

Introduction

Stress has been implicated in human disease processes. World Health Organisation estimated that 5-10% of population suffer from depression at any one time. Hans Hugo Bruno Selye defined stress as the non-specific response of the body to stressor [1]. Stress exposure activates the autonomic nervous system through its sympathetic branch that triggers peripheral responses, such as increased respiration, heart rate and blood pressure and allocates metabolic resources to promote defensive behaviour. Stressors activate the hypothalamic-pituitary-adrenal axis (HPA-axis) through the release of corticotrophin-releasing hormone (CRH) from the paraventricular nucleus (PVN) of the hypothalamus [2].

Pituitary adenylate cyclase-activating polypeptide (PACAP), a neuropeptide belonging to the vasoactive intestinal polypeptide/secretin/glucagon family has an ability to stimulate adenylate cyclase in anterior pituitary cells and to increase the release of pituitary hormone including corticotrophin [3]. When CRH reaches the anterior pituitary gland, it elicits adrenocorticotropic hormone (ACTH) release, which prompts glucocorticoid synthesis in the adrenal glands. Glucocorticoids are then released into the blood stream where they travel and bind to receptors throughout the body and brain. Glucocorticoids adapts an individual to the neurophysiological changes that occur during stress and helps to mobilize energy and cope with stressful experiences [2].

Negative interpersonal situations such as intimate partner violence and low perceived social support add additional vulnerability for stress and depression in women [4]. Selye's concept of eustress and distress are two different reactions to stress which can occur simultaneously or separately. Eustress is a positive cognitive response to a stressor. This type of stress is associated with positive feelings and a healthy physical state. While distress is a severe stress associated with negative feelings and physical impairments. The main factor that determines whether a stressor will cause distress or eustress is the perception and interpretation of the situation by the individual. Stress can disturb one's physical, mental, emotional and behavioural balance. It can cause autonomic imbalance and can affect heart rate, respiration, blood pressure, body temperature, metabolism, digestion, appetite, sleep, fertility, working conditions, etc. [5].

If exposure to stressors continues for a longer period of time, chronic health problems can develop and can even lead to diseased states. An individual goes through three stages while suffering from stress. In alarm stage, an individual experiences overacting of the sympathetic nervous system and the whole body starts preparing itself to fight against the reason of stress. In resistance stage, the body keeps making continuous efforts to cope with stress and therefore feels run down and gets mentally and physically weak. In exhaustion stage, the stress could reach a height where the individual may fell completely exhausted and helpless [6].

Popular and academic interest in yoga for treatment of health conditions are increasing while 30 million people claim to practice yoga for health benefit worldwide. The practice of yoga originated in India around 5000 BC. It combine specific postures (asanas), breathing techniques (pranayamas), meditative techniques (dhyanas), chants (mantras) and wisdom teachings (sutras). Yoga therapy is the process of empowering individuals to progress toward improved health and wellbeing [7]. Yoga has been adopted as a safe and effective way to promote physical activity, improving strength, balance and flexibility as well as potential benefit for people with stress [8] and depression [9], high blood pressure [10], heart disease, aches and pains. Psychological symptoms and disorders (anxiety, depression), autoimmune conditions, pregnancy, weight loss can all be positively affected by yoga. Yoga has positive impact on hormone regulation by lowering cortisol levels. Yoga has influence on the sympathetic and parasympathetic activity in the autonomic nervous system. Yoga affects the nervous system, making the parasympathetic nervous system

more dominant and stabilizing the autonomic nervous system to enhance resistance to the effect of stress. Research shows individuals who practice yoga indeed become more resilient to stress and have a decrease risk for cardiorespiratory diseases [11].
In recent decades, major efforts have been made by yoga experts in bringing yoga knowledge to a wider public. Scientists from various fields conduct research that shows positive effects yoga knowledge and techniques can have on physical, mental and emotional health of a human, and also how its implementation may contribute to the development of humans and their potential, and thus development of the society as a whole [12].
The present study was undertaken to assess the cardiovascular response to yoga in a group of stressed Manipuri women to acknowledge yoga as a safe and effective aspect of preventive and therapeutic care.

2. Materials and Methods

The present study was a prospective study, conducted in the Department of Physiology, Regional Institute of Medical Sciences (RIMS), Imphal in collaboration with Yoga Training and Research Centre (YTRC), Imphal after getting approval from the Institutional Ethics Committee. The study was done from January 2014 to July 2015. Fifty (50) stressed Manipuri women in the age range of 18-45 years were included in the study. A proforma of all the subjects were maintained wherein a brief clinical information, family, menstrual, personal and dietary history were taken. Proper general and systemic examination was done and an informed written consent was obtained from the participants after explaining the purpose of the study. A questionnaire using The Holmes and Rahe Stress Scale (Holmes TH & Rahe RH, 1967) [13] was described or given to each of the participants. The stress scale is a questionnaire consisting of 43 questions enquiring of the events that have happened to them in the past one year. Participants who scored <150 were adjudged as having low to moderate stress (stress level 1), 150-299 as moderate to high stress (stress level 2), and >300 as having very high stress (stress level 3). Levels of stress were then assessed for each of them. The study parameters were recorded at the start of yoga training and after 3 months of yoga training. The yogic practices were given by an expert for a period of 3 months, 1 hour in the morning each day for 6 days per week (Table 1). Those with past yoga training, male gender, age below 18 and above 45 years were excluded from the study.

Table 1: Yogic practices given

On Monday, Tuesday, Thursday and Friday	**On Wednesday**
Breathing practices – 5 minutes	Loosening exercise – 7 minutes
Instant relaxation technique – 1 minute	Surya Namaskar – 3 minutes
Loosening exercise – 10 minutes	Pranayama – 50 minutes
	On Saturday
Quick relaxation technique – 5 minutes	Loosening exercise – 30 minutes
Surya Namaskar – 3 minutes	Quick relaxation technique – 5 minutes
Asanas – 30 minutes	Surya Namaskar – 5 minutes
Deep relaxation technique – 7 minutes	Deep relaxation technique – 15 minutes

The parameters studied were baseline heart rate (HR) and blood pressure (BP), heart rate (HR) response to standing, heart rate (HR) response to Valsalva Manoeuvre, blood pressure (BP) response to standing, blood pressure (BP) response to sustained handgrip (recorded by means of hand dynamometer IMI-2095, India Medico Instruments, Delhi – 6).
Before recording the above parameters, the procedures were explained to the subject and the subject was asked to relax physically and mentally for 30 minutes. The resting heart rate and blood pressure were recorded first, followed by other tests. Room temperature was also recorded. Metallic objects were not allowed to be worn. The resting time after each test was 5-10 minutes. The following tests were performed in the specific sequence as given below.

2.1. Resting heart rate – Apparatus: Electrocardiograph (Cardiart 108T/MK-ECG machine). Procedure: Lead II of ECG was selected for recording heart rate (HR). Calibration was done and maintained throughout the procedures. Tracing speed was 25 mm/sec. HR was recorded in supine position by conventional method during normal quiet breathing for a period of one minute. The average R-R interval was measured manually and HR was calculated (HR=1500/RR interval).

2.2. Resting blood pressure (Systolic and Diastolic BP) – Apparatus: Mercury sphygmomanometer (Diamond), Stethoscope (Litmann). Procedure: BP was recorded with a mercury sphygmomanometer in supine position in right upper limb by auscultatory method using a stethoscope. Three (3) readings were taken at an interval of 15 minutes each and the average of the three values were taken.

2.3. 30:15 R-R ratio (HR response to standing) – Apparatus: ECG machine (Cardiart 108T/MK), Timer. Procedure: After a complete rest of 10 minutes in supine position, the ECG recording was started and the subject assumed erect posture as quickly as possible within 3 seconds with continuous recordings. Calculation : The ratio of the longest R-R interval around 30^{th} after standing to the shortest R-R interval around 15^{th} beat after standing were calculated for the result of 30:15 R-R ratio.

2.4. Valsalva ratio (Heart rate response to Valsalva manoeuvre) – ECG machine (Cardiart 108T/MK), Timer, modified mercurial sphygmomanometer (in which a mouth piece and a body tube of a 50 ml disposable hypodermic syringe in place of the air pump is connected directly to the tube leading to mercury bulb with a small leak in the mouthpiece). Procedure: The test was done after another 5 minutes interval of rest in sitting position. The subject was instructed to exhale forcefully through the mouthpiece of the modified mercurial sphygmomanometer and to maintain pressure in the manometer upto 40 mmHg for 15 seconds. ECG was taken during the manoeuvre and continued for about 30 seconds after the performance. The manoeuvre was repeated for 3 times with a 5 minutes time interval of rest. Calculation: The ratio of the longest R-R interval after blowing, to the shortest R-R interval during blowing or immediately after blowing was calculated. The highest ratio of the 3 manoeuvres was used as the result of Valsalva ratio (VR).

2.5. BP response to standing – Apparatus: Mercury sphygmomanometer (Diamond), Stethoscope (Litmann). Procedure: After 5 minutes of rest in supine position, resting BP was recorded. Then, the subject was asked to stand immediately and remain still without movement. BP was recorded after 0.5 minute, 1 minute and 3 minutes in the erect posture.

2.6. Blood pressure response to sustained handgrip – Apparatus: Handgrip dynamometer (25kg model IMI-2095, India Medico Instruments, Delhi), mercurial sphygmomanometer, stethoscope (Litmann). Procedure: A basal BP was recorded in sitting position first. Then the subject performed maximum grip of the handgrip dynamometer and the maximum capacity from the graduation was noted down. After 5 minutes rest, the subject was asked to hold the grip with 30% of the maximum capacity for 6 minutes. While performing this sustained grip, BP was recorded every 2 minutes. Near the end of the performance (at the end of 6 minutes), BP recorded just before the release of the grip was noted.

2.7. Statistical analysis: Statistical analysis was done using statistical software SPSS version 21. Paired t test and one way ANOVA test were used to analyze the quantitative data and to determine the p-value. A p-value of < 0.05 was used to indicate statistical significance in all the analyses and interpretations were made accordingly.

3. Results

Of the 50 women (mean age = 35.42±6.49 years), 8(16%) had stress level 1, 30(60%) had stress level 2 and 12(24%) had stress level 3 respectively (Figure 1).

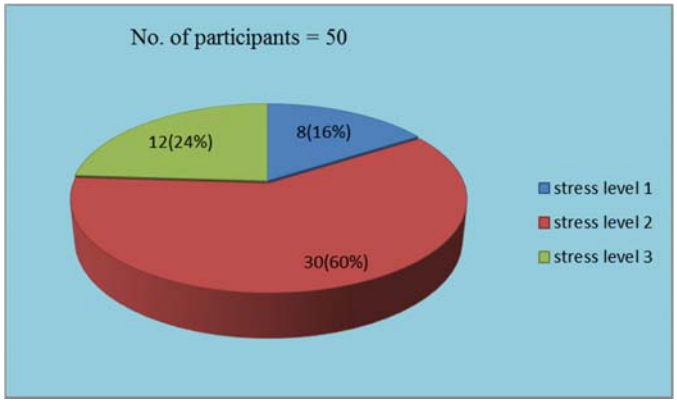

Fig 1: Stress level scoring in participants

Table 1: Comparison of resting heart rate before and after yoga training

Test	Before yoga (mean±SD)	After yoga (mean±SD)	p-value
HR (beats/min)	83.28±8.83	76.04±9.84	0.000**

**indicates highly significant (p<0.05) value

Table 1 shows the comparison of resting heart rate before and after yoga training. The mean resting heart rate before yoga training was 83.28±8.83 beats/min and it significantly decrease (p=0.000) to 76.04±9.84 beats/min after yoga training.

Table 2: Comparison of heart rate response to standing (30:15 R-R ratio) and Valsalva Ratio (VR) before and after yoga training

Tests	Before yoga (mean±SD)	After yoga (mean±SD)	p-value
30:15 R-R ratio	1.01±0.133	1.08±0.106	0.000**
VR	1.24±0.166	1.40±0.234	0.000**

**indicates highly significant (p<0.05) value

Table 2 shows the comparison of heart rate response to standing (30:15 R-R ratio) and Valsalva Ratio (VR) before and after yoga training. It depicts significant increase in 30:15 R-R ratio from 1.01±0.133 to 1.08±0.106 (p=0.000) and VR increase from 1.24±0.166 to 1.40±0.234 (p=0.000).

Table 3: Resting systolic BP and systolic BP response to standing before and after yoga training

Tests	Before yoga (mean±SD)	After yoga (mean±SD)	p-value
Resting SBP (mmHg)	131.36±8.28	124.08±10.21	0.000**
0.5 min SBP (mmHg)	130.76±7.06	122.68±9.60	0.000**
1 min SBP (mmHg)	128.76±6.93	121.16±9.28	0.000**
3 min SBP (mmHg)	127.08±6.62	120.12±9.00	0.000**

**indicates highly significant (p<0.05) value

Table 3 shows the resting systolic BP and systolic BP response to standing before and after yoga training. The resting systolic BP significantly decreases (p=0.000) from 131.36±8.28 mmHg to 124.08±10.21 mmHg. Results for systolic blood pressure response to standing at 0.5 minute, 1 minute and 3 minutes show significant decrease after yoga training.

Table 4: Resting diastolic BP and diastolic BP response to standing before and after yoga training

Tests	Before yoga (mean±SD)	After yoga (mean±SD)	p-value
Resting DBP (mmHg)	86.40±10.71	78.76±11.79	0.000**
0.5 min DBP (mmHg)	92.88±10.08	83.64±10.03	0.000**
1 min DBP (mmHg)	89.84±10.38	83.04±11.26	0.000**
3 min DBP (mmHg)	87.36±10.72	81.76±9.26	0.000**

**indicates highly significant (p<0.05) value

Table 4 shows resting diastolic BP and diastolic BP response to standing before and after yoga training. The resting diastolic BP significantly decreases (p=000) from 86.40±10.71 mmHg to 78.76±11.79 mmHg. Results for diastolic blood pressure response to standing at 0.5 minute, 1 minute and 3 minutes show significant decrease after yoga training.

Table 5: Blood pressure response to sustained handgrip before and after yoga training

Tests	Before yoga (mean±SD)	After yoga (mean±SD)	p-value
SBP (mmHg)	134.48±7.86	137.92±7.20	0.000**
DBP (mmHg)	91.80±8.33	80.28±8.98	0.000**

**indicates highly significant (p<0.05) value

Table 5 shows blood pressure response to sustained handgrip before and after yoga training. It depicts that SBP response to sustained handgrip increases (p=0.000) from 134.48±7.86 mmHg to 137.92±7.20 mmHg and DBP response to sustained handgrip shows significant decrease (p=0.000) from 91.80±8.33 mmHg to 80.28±8.98 mmHg.

Table 6: ECG findings before and after yoga training

Parameter	Before yoga (mean±SD)	After yoga (mean±SD)	p-value
P-wave (voltage in mV)	0.146±0.158	0.134±0.101	0.457
P-wave (duration in sec)	0.058±0.010	0.060±0.012	0.301
QRS (voltage in mV)	0.730±0.277	0.789±0.260	0.002*
QRS (duration in sec)	0.053±0.007	0.054±0.010	0.261
T-wave (voltage in mV)	0.241±0.090	0.248±0.083	0.120
T-wave (duration in sec)	0.170±0.056	0.169±0.061	0.819
PR interval (duration in sec)	0.111±0.012	0.114±0.017	0.166
ST segment (duration in sec)	0.057±0.009	0.055±0.011	0.146

*indicates significant (p<0.05) value

Table 6 shows ECG findings before and after yoga training. It depicts that there is no significant change in ECG findings except significant increase in QRS voltage (p=0.002).

Table 7: Stress-related cardiovascular changes

Tests	Stress level	No. of cases	Before yoga (mean)A	After yoga (mean) B	Mean diff. (B-A)	p-value
HR (beats/min)	1	8	86.13	79.77	6.375	0.000**
	2	30	82.70	74.70	8.000	0.000**
	3	12	82.83	76.04	6.793	0.000**
SBP (mmHg)	1	8	124.75	118.00	-6.750	0.006*
	2	30	133.80	126.93	-6.867	0.000**
	3	12	129.67	121.00	-8.667	0,000**
DBP (mmHg)	1	8	80.25	75.25	-5.00	0.000**
	2	30	88.73	81.13	-7.60	0.000**
	3	12	84.67	75.17	-9.50	0.000**
30:15 R-R ratio	1	8	0.926	1.061	0.135	0.019*
	2	30	1.056	1.115	0.059	0.000**
	3	12	0.966	1.043	0.077	0.000**
VR	1	8	1.223	1.339	0.116	0.003*
	2	30	1.250	1.434	0.185	0.000**
	3	12	1.228	1.354	0.127	0.000**

**indicates highly significant and *indicates significant (p<0.05) value

Table 7 shows stress-related cardiovascular changes before and after yoga training. It depicts statistically significant improvement in cardiovascular function after yoga training. The decrease in heart rate is greater in stress level 2 than those with stress level 1 and 3. SBP and DBP decrease is more in stress level 3 than stress level 1 and 2. 30:15 R-R ratio increases more in stress level 1 and VR increase is more in stress level 2.

4. Discussion

The present study was conducted in fifty (50) stressed Manipuri women in the age range of 18-45 years. Various autonomic function tests were carried out in the Department of Physiology, RIMS, Imphal before the start of yoga training and after three (3) months of yoga training.

4.1. Resting heart rate and and blood pressure: Resting heart rate and blood pressure of the subjects were comparatively higher before the start of yoga training than after completion. This finding is similar with the results of Bhimani NT *et al* [14] and Srivastava RD *et al* [15]. These findings show that there is parasympathetic dominance after yoga training.

4.2. Heart rate response to standing (30:15 R-R ratio): Heart rate response to standing, 30:15 R-R ratio showed significantly increase result after yoga training. This finding relates to the findings of Mourya M *et al* [16] and Deepak D *et al* [17] where the 30:15 R-R ratio showed significant improvement in parasympathetic nervous system activity.

4.3. Heart rate response to Valsalva Manoeuvre (VR): Result show significant increase of heart rate response to valsalva manoeuvre after yoga training which relates to the findings of Bharshankar JR *et al* [18] and Peter R *et al* [19]. The result indicates parasympathetic dominance after yoga training.

4.4. Blood pressure response to standing : The resting, 0.5 minute, 1 minute and 3 minutes systolic and diastolic BP in response to standing show significantly lower result after yoga training which is indicative of reduced sympathetic response. However, Pal A *et al* [20] found that sympathetic reactivity was reduced to some extent in yoga group but not statistically significant.

4.5. Blood pressure response to sustained handgrip: Result show significant increase of SBP rise in response to handgrip test after yoga training but show significant decrease in DBP rise to handgrip test after yoga training. Telles S *et al* [21] found statistically increase in handgrip strength after yoga training.

4.6. ECG changes: Result show non-significant changes in the ECG recording after yoga training except for significant increase in QRS voltage which may be due to improved ventricular function. Maini S *et al* [22] found no significant changes in their study.

5. Conclusion

The mean resting heart rate and blood pressure of the subjects decrease significantly after three months of yoga training and is due to parasympathetic dominance over sympathetic activity after yoga training. There was significant increase in heart rate response to standing (30:15 R-R ratio) and to Valsalva manoeuvre (VR) after yoga training and this indicates increase in parasympathetic activity after yoga training. The increase in 30:15 R-R ratio and Valsalva ratio were more in stress levels 2 and 3 implicating the beneficial effect yoga have on higher stress levels. The systolic and diastolic BP response to standing showed significantly lower result after yoga training and lower rise in blood pressure after yoga training is indicative of reduced sympathetic response. There was significant decrease in DBP rise to sustained handgrip test after yoga training and this indicates a lower sympathetic drive after yoga training. Non-significant changes in ECG findings after yoga training except for a significant increase in QRS wave suggest yoga might have role in improving ventricular performance. Thus, it can be concluded that yoga through its effect on stabilizing the parasympathetic and sympathetic function have significant role in combating various forms of stress an individual might encounter in day-to-day life. Therefore, yoga can provide health benefits in one's life through its preventive as well as curative aspects.

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