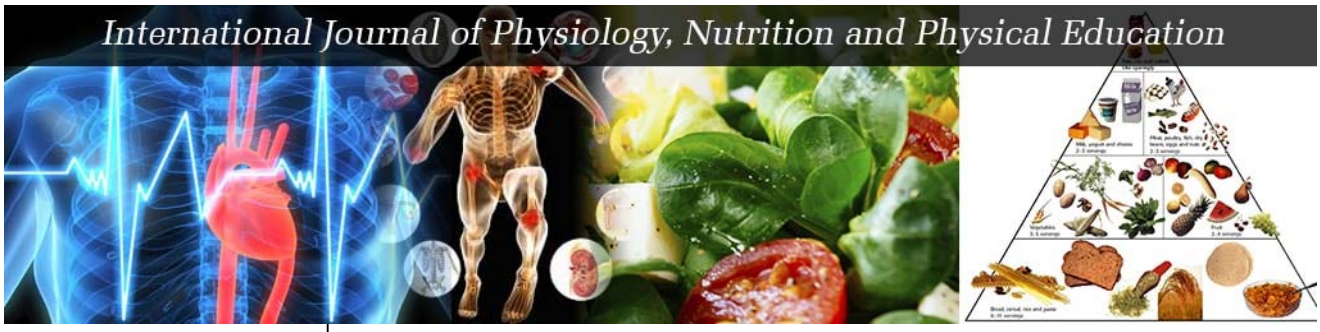

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A study on Pranayam and its effects

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Abstract
Yoga is a process of gaining control over the mind, as defined by Patanjali. Stress has been implicated as one of the major causes of essential hypertension. Yoga works on every cell of the body. Yoga influences body as well as controls the stress in the individual. An index of the processing ability of central nervous system and a simple means of determining sensory-motor performance is referred to as reaction time (RT). It has been proclaimed that human performance including central neural processing is improved by yoga training. It improves cardiorespiratory performance, balances autonomic nervous system, decreases pulse, respiratory rate, systolic and diastolic blood pressure.
Yoga is a helpful intervention in hypertensive subjects. Yoga and pranayam are more beneficial to hypertensive subjects. RT is an index of cortical arousal, and a decrease in it indicates an improved sensory-motor performance and an enhanced processing ability of the central nervous system.

Keywords: Yoga; Pranayam; Reaction time

Introduction
Yoga is a process of gaining control over the mind, as defined by Patanjali in his second aphorism (Yoga Sutras: 1.2). Lifestyle related diseases such as coronary artery disease, obesity, and hypertension are shockingly on the increase in our modern society [1-3]. Stress has been implicated as one of the major cause of essential hypertension [4-6].
Treatment by weight reduction, yoga, and muscle relaxation each produces smaller but appreciable changes in blood pressure [7-9]. Yogic techniques especially Dhyana and Shavasana improve attentiveness. Increased attentiveness decreases reaction time.
The time interval between the application of a stimulus and the emergence of appropriate voluntary response by a subject is called RT. It involves stimulus processing, decision making, attention mechanism, and response programming [10]. With this point of view, we aim to study the degree of effect that yoga brings in normal subjects when compared with hypertensive subjects in terms of human RT, blood pressure, and various other physiological parameters.
This study shows the effects of yoga and pranayam on auditory and visual reaction time and on certain physiological parameters such as weight, body mass index, pulse rate, respiratory rate, systolic blood pressure, and diastolic blood pressure in normal and hypertensive subjects.
In accordance to our finding, Khadka *et al*. [4] showed significant decrease in body weight after yoga. Khadka *et al*. [4] and Tundwala *et al*. [11] showed statistically significant reduction in BMI, similar to our results. The mechanism of the beneficial effect of yoga in the management of obesity cannot be explained by simple excess caloric expenditure because practice of asanas does not bring about increased, rapid large muscle activity and energy generation. However, yoga in the management of obesity is of significance [12].
Bharshankar *et al*. [13] Vijayalakshmi *et al*. [14] and Khadka *et al*. [4] showed significant reduction of pulse rate after yoga training. These results are similar to our study. Slow breathing as in yogic practice enhances heart rate variability and baroreflex sensitivity by resynchronizing inherent cardiovascular rhythms [12]. This is owing to increased vagal modulation [15, 16].
Yoga-based guided relaxation helped in the reduction of sympathetic activity with reduction in heart rate, skin conductance, oxygen consumption, and increase in breath volume [17, 18].
Statistically significant reduction in pulse rate after regular practice of yoga is attributed to increased vagal tone.

Decreased sympathetic activity reduces catecholamine secretion and also leads to vasodilation leading to improvement in peripheral circulation. Regular yogic practices reduce basal metabolic rate and resting oxygen consumption [12]. All these may be responsible for reduction in resting pulse rate.

Materials and methods

This comparative type of study was carried out in the yoga center in central India on normal and hypertensive individuals for 3 months. Approval from the Institutional Ethics Committee was obtained. The study included 70 normal and 70 hypertensive subjects. Planned study population included control group fulfilling the following criteria: Normal healthy adult volunteers between 30 and 60 years of age of both genders, nonsmoker, nonalcoholic, not doing yoga previously, and not on any medication. Inclusion criteria for the study group: Subjects with essential hypertension, which included subjects between 30 and 60 years of age with hypertension diagnosed within last 5 years and are on same medication since 5 years, nonsmoker, nonalcoholic, and not doing yoga previously.

Exclusion criteria: Subjects with stage-1 hypertension, not on any medication; with stage-2 hypertension; with hypertension with cardiovascular or cerebral complications; with secondary hypertension; and with chronic diseases other than hypertension were excluded from the study. Subjects already practicing yoga and pregnant women were also excluded.

Planned Intervention: After taking consent, a detailed history of the subjects was taken. General and systemic examination of the subjects was done. After screening with physical examination, subjects underwent yogic session daily for oneand-a-half hour duration from 6 am to 7.30 am in the morning for a period of 90 days (i.e., 3 months). The session started with Awayawa–dhyana and a short prayer, followed by various asanas such as paschimottanasan, vrukshasan, tadasan, padmasan, ardhpadmasan, pranayam, and meditation and ended with a short prayer. Parameters were measured on admission to yoga center (i.e., on the 1st day and after 3 months). Parameters measured were age (years), height (cm), weight (kg), body mass index (BMI) (kg/m2), pulse rate (beats/min), respiratory rate (respiration/min), blood pressure (mm Hg). RT (milliseconds) was measured by "Response analyzer."

Statistical Analysis: Clinical parameters were compared between the 1st day and after 3 months in normal and hypertensive subjects by performing paired t-test. Categorical variables were compared by $\chi 2$ -statistics. All the tests were two-sided.

Table 1: Effect of yoga on different parameters

	1st day	After 3 months	*P*	Mean change	*p*
Weight (kg)					
Normal	70.11 ± 5.29	67.17 ± 5.42	<0.0001**	3.04 ± 2.77	0.0030**
Hypertensives	71.39 ± 8.20	67.26 ± 7.44	<0.0001**	4.28 ± 1.53	
BMI (kg/m²)					
Normal	26.27 ± 2.71	25.23 ± 2.71	<0.0001**	1.15 ± 1.22	0.0055**
Hypertensives	26.12 ± 3.47	24.62 ± 3.15	<0.0001**	1.54 ± 0.59	
Pulse rate (beats/min)					
Normal	72.7 ± 3.19	69.31 ± 2.85	<0.0001**	3.15 ± 2.64	0.0104*
Hypertensives	76.72 ± 4.63	72.24 ± 3.79	<0.0001**	4.78 ± 2.01	
Respiratory rate (respiration/min)					
Normal	14.42 ± 2.37	11.90 ± 1.51	<0.0001**	3.00 ± 2.33	0.0004**
Hypertensives	17.4 ± 2.04	12.9 ± 1.58	<0.0001**	4.37 ± 1.50	
SBP (mm Hg)					
Normal	116.45 ± 2.68	112.05 ± 1.95	<0.0001**	4.63 ± 1.99	0.0004**
Hypertensives	136.11 ± 7.88	130 ± 7.01	<0.0001**	6.20 ± 3.05	
DBP (mm Hg)					
Normal	76.02 ± 2.95	71.73 ± 2.31	<0.0001**	4.70 ± 1.90	0.0013**
Hypertensives	88.0 ± 4.34	82.25 ± 3.79	<0.0001**	5.83 ± 1.83	
ART (milliseconds)					
Normal	181.05 ± 9.93	166.31 ± 6.50	<0.0001**	15.55 ± 6.01	0.0442*
Hypertensives	184.5 ± 10.18	166.78 ± 8.22	<0.0001**	17.88 ± 6.54	
VRT (milliseconds)					
Normal	196.17 ± 5.28	185.25 ± 4.72	<0.0001**	10.91 ± 4.72	<0.0001**
Hypertensives	192.25 ± 8.33	176.35 ± 6.76	<0.0001**	15.9 ± 5.62	

*$p < 0.05$, statistically significant; **$p < 0.01$.

Result

Weight, BMI, pulse rate, and respiratory rate were found to be significantly decreased in hypertensive subjects when compared with normal subjects. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) also decreased significantly in hypertensive subjects when compared with normal subjects. The decrease in ART and VRT was statistically significant in hypertensive subjects when compared with normal subjects. The subjects were given yoga training including asanas, pranayam, and meditation for 3 months. Physiological parameters such as weight, BMI, pulse rate, respiratory rate, SBP and DBP, ART, and VRT were studied at the beginning of the study and after 3 months.

Discussion

Our results are similar to the findings of Doijad and Surdi [19] and Abel *et al*. [20] They found significant decrease in RR. Recitation of the yoga mantras (chanting) slowed respiration to almost exactly six breaths per minute and enhanced heart rate variability and baroreflex sensitivity [12]. By following pranayama for few weeks, the bulbopontine complex is adjusted to a new pattern of breathing which is slower than its basal rhythm causing decrease in respiratory rate [15]. During daily practice of pranayama, the fundamental activity of bulbopontine complex is altered in such a way as to bring down its rhythm by voluntarily extending the phases of inspiration and expiration by stretching to their fullest extents,

thus making the lungs to work to their maximal extent to take O2 and expire CO2 maximally.

The mechanism of yoga-induced blood pressure reduction may be attributed to its beneficial effects on the autonomic neurological function. Impaired baroreflex sensitivity has been increasingly postulated to be one of the major causative factors of essential hypertension. Practice of yogic postures has been shown to restore baroreflex sensitivity [12, 15]. Level of adverse neurohormonal activity can be quantitated by the measurement of specific markers in serum and urine. It has been described that regular practitioners of yoga asanas showed a significant reduction in the markers of intrinsic neurohormonal activity such as urinary excretion of adrenaline, noradrenaline, dopamine, aldosterone, as well as serum testosterone and luteinizing hormone levels.

It is known that the mental state can influence the hypothalamic-pituitary-adrenal (HPA) axis and alter the cortisol levels. Cortisol, discharged from the adrenal cortex, is a biochemical index of HPA axis activation and is a significant marker associated with psychological stress.

Yoga promotes a reduction in sympathetic activation, enhancement of cardiovagal function, and a shift in autonomic nervous system from primarily sympathetic to parasympathetic, increased vagal tone, decreased workload on heart, decreased cardiac output, and decreased SBP [2]. Asanas such as paschimottanasan have been proved to increase baroreceptor sensitivity. Yogic practice, through the restoration of baroreceptor sensitivity, resulted in significant reduction in the blood pressure of patients who participated in yoga exercise.

Regular practice of meditation is linked with increased thickness in a subset of cortical regions associated with somatosensory, auditory, visual, and interoceptive processing. Activation of right hemisphere is seen during the actual act of meditation.

It is especially fascinating to find that a lot of changes linked with the active meditation state were noted in the frontal lobe. This area is involved with the focus of attention. Regular meditation practice may bring down age-related thinning of the frontal cortex. Increased cortical thickness could be owing to greater arborization per neuron, increased glial volume, or raised regional vasculature [4]. The right anterior insula is associated with bodily attention and raised visceral awareness. Increased thickness in this region is associated with increased capacity for awareness.

The right hemisphere is essential for sustaining attention, which is a center for insight meditation. It has been hypothesized that by becoming increasingly more aware of sensory stimuli during formal practice, the meditation practitioner is progressively able to use this self-awareness to more successfully navigate through potentially stressful encounters that emerge throughout the day.

Long-term meditation practice is linked with modified resting electroencephalogram patterns, indicative of long-lasting alterations in brain activity. Meditation reflects cognitive brain functions such as sequential information processing, stimulus discrimination, and short-term memory.

Conclusion

It was found that changes in the physiological parameters were significant in hypertensive subjects when compared with normal individuals. Yoga is a helpful intervention in hypertensive subjects. Yoga and pranayam are more beneficial to hypertensive subjects than normal individuals. In normal subjects, yoga is helpful for keeping the parameters at the baseline, which plays a role in prevention of the disease. Pranayam and meditation improve (a) sensory information processing ability; (b) central integration of learning and memory, and (c) motor function and coordination, visual scanning, mental flexibility, sustained attention, psychomotor speed, and speed of information processing.

These skills improves sustained attention. This probably improves ART and VRT. This is of applied value in conditions needing faster reactiveness such as sports, machine operation, race driving, and specialized surgery. It may also be of value to train mentally challenged children and older sports persons who have prolonged RT. Moreover, yoga and pranayam reduce weight, pulse rate, and blood pressure, which are the risk factors for noncommunicable diseases.

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