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Effects of Four Weeks of Yogic Exercises on Certain Selected Physiological Parameters in Women

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KEY WORDS Heart Rate. Peak Expiratory Flow. Blood Pressurse. Body Fat. Maximum Oxygen Uptake.

ABSTRACT The present study was undertaken on 20 female volunteers who were undergoing the certificate course at SAI NSNIS, Patiala. They undertook a total of four hours of yoga exercises, six days a week for four weeks. Before the training programme started, the volunteers were physiologically assessed for their weight, body fat percentage, resting heart rate, resting systolic and diastolic blood pressure, lung function test involving measurement of vital capacity (VC), forced expiratory volume in one second (FEV_1), peak expiratory flow (PEF), and maximum oxygen uptake capacity (VO_2 max) was assessed by a computerised metabolic analyser, by graded cycle ergometry. A two test battery, involving lying to standing test and cold pressor test were used to assess the functional status of their autonomic nervous system. The same measurements were repeated after four weeks of yoga training. It was observed that body fat percentage was reduced significantly and so did the resting heart rate and resting (standing) systolic blood pressure. The VO_2 max exhibited significant improvement and the PEF was also found to improve significantly . Our findings strongly suggests, among others, that although significant changes and alterations have been effected in four week yoga training in some of the parameters, but possibly a greater time period is required to affect the physiology of major body systems and cause a significant generalised change in the physiological status.

INTRODUCTION AND BACKGROUND

Yoga is an ancient discipline which was evolved more than 4000 years ago in India. The word 'yoga', is derived from the Sanskrit word, 'Yuj', which means 'union' or 'to unite'. Yoga exemplifies the union of the mind and the body, promoting physical, mental and spiritual health. Yoga, therefore, is an holistic system for the training of the body, mind and soul.

Practising of yoga has been seen to affect the physiological systems of the body and increases the concentration, lowers the stress and tension and decreases the heart rate and maintains the blood pressure. The physiological responses is further characterised by decrease in oxygen consumption, metabolic rate, frequency of respiration, cardiac output and blood lactate. Studies have concluded that systematic use of yoga results in better autonomic patterns and greater control and co-ordination.

Regular practice of yoga have also been found to increase the efficiency of circulation and enhances communication between cells via the transportation of biochemical signals such as hormones, neurotransmitters and immunotransmitters. Singh et al. (1972) had observed that the practice of Hatha yoga improves respiratory, cardiovascular and adrenocortical function and caused a decreased incidence of physiological and psychological complaints. Although yoga exercises are mostly thought of as stationary and isometric , however they may also be extremely dynamic with varied velocity of movements . In addition to isometric muscle contraction both concentric and eccentric muscle activity are also incorporated.

The reaction time, heart rate response, cold pressor test, etc., are some of the markers which can be used for measuring the physiological effects of yoga, especially on the autonomic nervous system or the ANS, which has an important function in maintaining internal environment of the human body. It was with this background that the present study was undertaken, to elucidate the effects of 4 weeks of yoga training on certain selected physiological parameters of women, who had no prior exposure to yoga.

REVIEW OF LITERATURE

Scientific studies have been earlier (Anand et al., 1961 ; Anand and Cheema, 1961) conducted on Yogis, who have been practising yoga for several years, to demonstrate the remarkable physiological potentialities of yoga. The yogis were seen to be able to increase their skin temperature (Benson et al., 1982), reduce oxygen consumption and heart rate (Wallace et al., 1971), by exerting a certain amount of voluntary control over the ANS (Wenger and Bagchi, 1961). Later studies were conducted on common people who practised asanas and yogic exercises (Selvamurthy et al., 1983 ; Ray et al., 1995, 2001).

Udupa et al. (1973, 1975), demonstrated an improvement in cardiorespiratory, biochemical and psychological functions following yogic exercises, in normal population. Joseph et al. (1981) observed significant differences following three months of yoga exercises on resting heart rate, the systolic and diastolic blood pressure, mean skin temperature and EEG activity, suggesting an altered autonomic balance in the subjects, resulting in a gradual shift of the autonomic equilibrium towards a relative parasympathetic dominance. They also observed significant increases in the lung volumes, peak flow rate, forced expiratory volume in 1 second, forced vital capacity and breath holding time in the volunteers after yoga training. Ray et al. (2001), have very recently observed that yoga caused a significant reduction in the resting heart rate, blood pressure, oxygen consumption and blood lactate levels, and significantly improved flexibility. They further observed that yoga training resulted in the subjects being able to achieve a higher VO_2 economy by consuming lesser oxygen at submaximal loads and exhibiting lower heart rate values at the submaximal levels. The peak lactate values were also significantly reduced in these subjects and the removal of blood lactate was hastened, compared to the control group. These findings suggest that yoga exercises, being low intensity in nature, possibly causes a shift of the anaerobic threshold to a higher level, thereby increasing endurance, without increasing the maximal aerobic capacity or VO_2 max.

MATERIALS AND METHODS

Subjects: The present study was conducted on 20 females in the age range of 20 to 30 years, having no previous exposure to yoga. They were drawn from the students undergoing the Certificate Course at SAI, NS NIS, Patiala and undertook a total of 4 hours of yoga exercises, six days a week, for four weeks. Since the group of volunteers carried out only yoga exercises and nothing else, the requirement of a control group was not felt as essential and obligatory.

Methods: Volunteers participating in the study was at first brought to the Exercise Physiology laboratory of SAI, NSNIS, Patiala and were apprised of the aims and objectives of the study. Thereafter, details of their corporal and physical data comprising of decimal age, sex, date of birth, height, weight, body surface area, body fat percentage, was duly recorded. The body fat percentages was calculated from the four skinfold measurements as described by Durnin and Womerseley (1974) and Brozek (1963) and Siri (1965).

Consequent to the recording of the physical / corporal data, the volunteers was subjected to a series of tests comprising of the following:

Recording of Physiological Transients at Rest: The resting blood pressure (BP), heart rate (HR), oxygen consumption (VO_2), vital capacity (VC), Forced expiratory flow (FEV), Peak expiratory flow (PEF) was recorded after a minimum period of 30 min rest in the supine position. The BP was measured by a mercury sphygmomanometer. The HR and VO_2 was assessed by the portable oxygen and carbon dioxide analyser (K4 System : Cosmed SRL, Italy) and VC, FEV_1 and PEF were assessed by the portable computerised Spirometer, "Flowscreen", Erich Jaeger, Germany.

A two test battery was used to assess the functional status of the autonomic nervous system of the volunteers:

(1) Lying to Standing Test: The volunteers was asked to stand up quickly from a supine position within 3 sec, and remain standing for two minutes, as described by Weiling (1992). The BP was recorded at 0.5th, 1st and 2nd minute of standing. The HR was recorded by the Heart rate telemetry system (HRTS : 'Sport tester', PE 3000, Polar Electro, Finland).

The volunteers were, thereafter asked to sit, and the second procedure was conducted with the volunteers in the sitting position.

(2) Cold Pressor Test: The baseline (pre-pressor test) BP was first recorded. The volunteers were thereafter asked to immerse their right hand in 10°C water for 1 min (Low, 1984). The BP was recorded at the 1st and 2.5th min after immersion of the hand in water.

Cardiopulmonary Assessment by Spirometry: The volunteers were evaluated for their various lung volumes and capacities by the portable computerised spirometer ('Flowscreen', Erich Jaeger, Germany). The equipment was calibrated by injecting a fixed volume of air by a precalibrated 2 litre pump (Erich Jaeger, Germany), before each evaluation. The volunteers was evaluated for their vital capacity (VC), forced expiratory volume in 1 sec (FEV_1), peak expiratory flow (PEF) and maximum voluntary ventilation (MVV).

Consequent to the evaluation of the cardio-respiratory parameters at rest, the Certificate

course started and the volunteers performed yoga exercises for four hours a day for six days a week, for 4 weeks, under the guidance of a trained Yoga Instructor. The yogic exercises was comprised of an exercise battery consisting of Pranayama, meditation, asanas, mudras, Pratyahara, Dhyana and Samadhi, and was same for every individual, in the same order. The yogic exercises was carried out in the early morning and evening at a prefixed time.

Physiological Assessment by CPET: Cardio-pulmonary exercise testing (CPET) was performed on an electronically operated bicycle ergometer (ER 900: Erich Jaeger, Germany), using a test protocol consisting of administration of a graded cycle ergometry, by all volunteers of the study, firstly, prior to the beginning of the yoga training and later, after 4 weeks of yoga training. The CPET consisted of a graded cycle-ergometry, where the initial load was prefixed at 50 watts, and was increased every two minutes at the rate of 50 watts, till exhaustion (Dey et al., 1993), consequent to which, the volunteers was asked to cycle with no load (recovery phase). The tests was carried out in an air conditioned room with temperature and humidity levels controlled at 23° $\pm$ 2°C and 55 $\pm$ 5%, respectively. The tests was carried out at least 3h after last meal and after a minimum of 12h of limited exertion.

All measurements was carried out breath-by-breath, using the computerised metabolic analyser, "Cosmed, K4 system", (Cosmed SRL, Italy). The heart rate (HR) monitored during the period of test and recovery. The volunteers breathed through a small dead space (35 ml), low resistance mouthpiece and TripleV volume transducer. Respired gases were withdrawn automatically from the mouthpiece and passed on to the CO_2 and O_2 analysers for display and recording of the various physiological variables. Temperature and pressure sensors of the instrument were automatically read the ambient temperature and atmospheric pressure, and data about existing relative humidity was fed to it. All gas volumes was automatically corrected for, and expressed in STPD, and V_E was expressed as V_E BTPS. The CO_2 and O_2 analysers were calibrated before each test using ambient air (open calibration).

Statistical Analysis: Students' 't' test was applied to compare the means of the various physiological transients under study, those obtained prior to the exercise, and those obtained following 4 weeks of yoga training. The analysis software of SPSS 6.0 package was used to compute the test results.

RESULTS AND DISCUSSIONS

The means of the resting HR (both sitting and standing)was found to be reduced significantly. The resting standing systolic blood pressure (BP) was also found to be decreased as a result of 4 weeks of yoga training. The difference in the mean diastolic BP was not found to be statistically significant. The four weeks of yoga training resulted significant loss of body fat. Although there was a slight increase in the weight indicating possible enhancement of muscle mass. Significant differences were also found to exist in the systolic BP on application of the cold pressor test, although the diastolic BP values were not significantly different. The systolic BP were also found to decrease in the 0.5th and 2nd min of lying to standing test, although the difference were not significant. Significant difference however existed in the lying to standing test diastolic BP at the 1st and 2nd minute. The VO_2 max exhibited significant improvement after 4 weeks of yoga exercise. The results of the lung function test depicted that the peak expiratory flow significantly increased after yoga training. However, the maximum voluntary ventilation and vital capacity although increased

Table 1: Comparison of the means (±SD) of the body weight, body fat, sitting and standing heart rate and maximum aerobic capacity, before and after four weeks of yoga exercises

Parameter	*Weight (kg)*	*Body fat %*	*Resting Pulse Rate (sitting)*	*Resting Pulse Rate (standing)*	*Maximum Aerobic Capacity (VO_2max)*
n	*22*	*22*	*22*	*22*	*22*
Before Yoga	51.9	13.62	77.36	81.64	39.56
	(9.13)	(6.05)	5.60	(5.74)	(9.08)
After Yoga	52.16	13.19	70.55	75.18	44.95
	(8.55)	(5.75)	(5.53)	(5.08)	(8.38)
Difference	-0.26	0.43	6.81*	6.46*	-5.39*

Note : * denotes significance at $p<0.01$.

Table 2: Comparison of compare the means (±SD) of the certain selected respiratory capacities before and after four weeks of yoga exercises

Parameter	*PEF*	*VC*	*MVV*	*FEV*
n	*22*	*22*	*22*	*22*
Before Yoga	5.44	2.90	88.92	2.63
	(1.19)	(0.51)	(13.99)	(0.44)
After Yoga	6.24	2.96	94.51	1.21
	(1.21)	(0.42)	(17.22)	(0.51)
Difference	-0.8	-0.06	-5.59*	1.42

substantially, were not found statistically significant.

The increase of the resting heart rate (both lying and standing) as well as the resting systolic (standing) BP clearly indicates a significantly reduced sympathetic tone as a result of yoga training. It was also observed in the study that in the case of resting systolic BP (supine), individuals predisposed to a higher systolic blood pressure exhibited significantly lower values after 4 weeks of yoga where as those individuals who exhibited a lower than normal value prior to yoga exercises displayed higher values, within the normal range of resting systolic BP.

This suggests the yoga or Yogic exercises can possibly fine tune the autonomic balance in its endeavour to bring the various physiological transients within the normal range. The lack of significance in some of the values can be attributable to the short span of training of one month, which may not be optimum for complete entrainment of the autonomic nervous system. These finding are in agreement with those

Table 3: Comparison of the means (±SD) of the blood pressure during cold pressor test before and after four weeks of yoga exercises

Parameter	*Systolic BP (1 min)*	*Diastolic BP (1 min)*	*Systolic BP (2.5 min)*	*Diastolic Bp (2.5 min)*
n	*22*	*22*	*22*	*22*
Before Yoga	107.00	74.09	103.27	72.91
	(10.40)	(8.70)	(10.82)	(8.32)
After Yoga	109.82	73.64	111.91	75.45
	(7.73)	(6.55)	(7.05)	(4.98)
Difference	-2.82	0.45	-8.84	-2.54

Note: *denotes significance at p<0.01.

Table 4: Comparison of the means (±SD) of the blood pressure during cold pressor test before and after four weeks of yoga exercises

Parameter	*Systolic BP (1 min)*	*Diastolic BP (1 min)*	*Systolic BP (2.5 min)*	*Diastolic BP (2.5 min)*
n	*22*	*22*	*22*	*22*
Before Yoga	107.00	74.09	103.27	72.91
	(10.40)	(8.70)	(10.82)	(8.32)
After Yoga	109.82	73.64	111.91	75.45
	(7.73)	(6.55)	(7.05)	(4.98)
Difference	-2.82	0.45	-8.64	-2.54

Table 5: Comparison of the means (±SD) of the blood pressure values during lying to standing test before and after four weeks of yoga exercises

Parameter	*Systolic BP (0.5min)*	*Diastolic BP (0.5min)*	*Systolic BP (1 min)*	*Diastolic BP (1min)*	*Systolic BP (2.0 min)*	*Diastolic BP (2.0 min)*
n	*22*	*22*	*22*	*22*	*22*	*22*
Before yoga	116.14	80.09	118.64	81.45	119.27	82.18
	(11.78)	(9.67)	(11.10)	(9.12)	(10.95)	(8.28)
After yoga	114.27	76.36	115.45	77.36	115.82	76.19
	(4.11)	(3.98)	(5.49)	(4.11)	(5.01)	(3.99)
Difference	1.87	3.73*	3.19*	4.09*	3.45*	5.99

Note : * denotes significance at p<0.01.

observed by Ray et al. (2001). The significant improvement of the VO_2 max strongly suggest that yoga can, and does improve the aerobic component causing an increase in endurance capacity. The ramification of these results cannot be overemphasised, particularly in relation to the possible beneficial effects of yoga on sports persons, in the quest for the enhancement of their performance. The increase of the respiratory capacities as a result of yoga training are in agreement with those observed by K.S Gopal et al. (1973) and Shirley Telles et al. (1993).The significant improvement in PEF, FEV, VC depicts that yoga can improve lung function values even in just four weeks of yoga training.

In conclusion, it can therefore be emphasised that yoga training was found to significantly alter the autonomic response profile of the volunteers under study. However, the period of one month of training may not be optimum for elucidating the full benefits. The results further suggests that since the maximum aerobic capacity can be improved by yoga exercises, the same can be incorporated in our sports training and it is imperative that yoga can positively influence the aerobic and endurance profile of athletes and can cause an enhancement of performance.

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