

EFFECT OF YOGIC EXERCISES ON PHYSICAL AND MENTAL HEALTH OF YOUNG FELLOWSHIP COURSE TRAINEES

U. S. RAY*, S. MUKHOPADHYAYA, S. S. PURKAYASTHA,
VIMLA ASNANI, O. S. TOMER, RAJENDRA PRASHAD,
LALAN THAKUR AND W. SELVAMURTHY

*Defence Institute of Physiology and Allied Sciences,
Lucknow Road,
Delhi - 110 054*

(Received on October 7, 1999)

Abstract : A study was undertaken to observe any beneficial effect of yogic practices during training period on the young trainees. 54 trainees of 20-25 years age group were divided randomly in two groups i.e. yoga and control group. Yoga group (23 males and 5 females) was administered yogic practices for the first five months of the course while control group (21 males and 5 females) did not perform yogic exercises during this period. From the 6th to 10th month of training both the groups performed the yogic practices. Physiological parameters like heart rate, blood pressure, oral temperature, skin temperature in resting condition, responses to maximal and submaximal exercise, body flexibility were recorded. Psychological parameters like personality, learning, arithmetic and psychomotor ability, mental well being were also recorded. Various parameters were taken before and during the 5th and 10th month of training period. Initially there was relatively higher sympathetic activity in both the groups due to the new work/training environment but gradually it subsided. Later on at the 5th and 10th month, yoga group had relatively lower sympathetic activity than the control group. There was improvement in performance at submaximal level of exercise and in anaerobic threshold in the yoga group. Shoulder, hip, trunk and neck flexibility improved in the yoga group. There was improvement in various psychological parameters like reduction in anxiety and depression and a better mental function after yogic practices.

Key words : yogic exercises autonomic nervous psychological
young trainees body flexibility submaximal exercise
blood lactate oxygen consumption

INTRODUCTION

Earlier studies were conducted on yogis who have been practicing Yoga for several years (1, 2, 3) as models to demonstrate the remarkable physiological potentialities

of yoga. The yogis could increase skin temperature (4) and could reduce voluntarily oxygen consumption and heart rate (5). These were achieved by voluntary control to a certain extent on their autonomic nervous functions (6, 7). Later

*Corresponding Author

studies were conducted on common men who were not yogis but practiced asanas and meditation for a short span of time without leading the strict regime of yogic life (10-12, 14-21, 29). Udupa et al (8, 9) showed improvement in cardiorespiratory, biochemical and psychological functions in their subjects who were not yogis but practiced yoga for some months. The usefulness of yoga and transcendental meditation in specific stress management technique for the people in different occupations with various psychological and physical stress are often discussed (24) to improve the coping reserve of an individual to face stress and to prevent stress related disorders. A systematic study concerning the specific age group with specific trade within the ambit of specific job related psychosocial stress and the effect of yogic exercises on it is very scanty. A study was undertaken on a group of young engineering fellowship course trainees who could be grouped under sedentary intellectual strata of the society. The aim was to observe the effect of yogic practices on certain aspects of physical and mental health of the young trainees when they were under constant pressure for better performance with the tight schedule of the course.

METHODS

Subjects : 44 EFC (Electronic Fellowship Course) and 10 MEFC (Mechanical Engineering Fellowship Course) students were taken for this study. 44 of them were male and 10 were female subjects. They were all healthy and within the same age group (20-25 yrs). The physical characteristics of the subjects are given in

Table I. They were divided randomly into two groups. One group (23 male and 5 female) was administered yogic exercises (YOGA) for first five months of the course while the other group i.e. CONTROL (21 male and 5 female) was not subjected to yogic exercises during this period. From the 6th to 10th month CONTROL group also practiced yogic exercises along with YOGA Group. At the commencement of the studies they were subjected to routine clinical examination and found to be healthy and free from any organic ailments. They were getting their food from the same mess. They were having a controlled physical activity schedule throughout the period of study other than the two months when they were out of the Institute for educational tour. During the period when they were staying out of the station, most of them were under the same schedule of daily routine and other activities. The subjects were under constant pressure of attending classes, preparing for the examinations and better performance within the tight schedule of the course. In spite of all these pressure of busy schedule, most of the subjects practiced yogic exercises regularly. The attendance of every participant was recorded on every day of performing yogic exercises.

Environment: The average environmental ambient temperature during the period of study varied from 10°C to 30°C. Relative humidity was 60-90%. Temperature of the laboratory was 26-28°C during the period of experiment.

Yogic schedule: The subjects were given training in selected yogic exercises of Hatha Yoga for one hour every alternate day in a week (3 days a week). Hatha yogic

practisees were performed under the guidance of three qualified yoga instructors trained in Kaivalyadhama, Lonavala, Maharashtra. Various yogic practices were selected by the yoga instructors (keeping the investigators in confidence) as it used to be administered as total package for all round development (mental and physical) of a young individual. This was found to be suitable for beginners and was developed by them through long experience of imparting yogic training to different categories of people in society. Detail about various asanas, pranayama and kriyas are given elsewhere(26, 27). Various yogic practices as performed by the subjects are given in Figure 1 and brief particulars of them are given below:

Relaxative postures

1. *Makarasana* : Lie prostrate. One hand over the other or apart, forehead or side of head resting over the hands. Legs wide apart.

Technique of relaxation:

- a) Observe natural breathing movement (expansion and retraction).
- b) Observe the pauses after inhalation and exhalation.
- c) Total body surface awareness: region taking part in breathing process
- d) Voluntary deep breathing-type-1

e) Voluntary breathing-slightly deeper than the natural breathing pattern-type 2

Voluntary breathing -exactly as per the need of the moment. Inhaling when the need is felt, exhaling when the need is felt-type 3

f) Nasal awareness: nostril-left dominant/right dominant/equal/both clogged.

2. *Shavasana* : Lie on the back, legs little apart, hands little away from the body. Head straight or tilted. Every joint of the body to be kept loose. Relaxation technique same as in 1

Health culture postures: Four fundamental points to be kept in mind while performing various asanas (postures): a) Stability b) Comfort c) Minimum effort d) Awareness. The going into the posture should be slow and releasing or undoing of the posture is also slow, in fact slower. Breath to be natural.

Asanas (on chest):

3. *Bhujangasana* : To lift the chin off the floor and then the chest and to keep the region below the naval on the floor.

- a) Casual-Hands and legs both to be loose.
- b) Modified-Hold the hands over the hips and stretch them. Feet should be together.
- c) Traditional-Palms should be by the side of the chest. Thumbs to be kept beside the breasts. Feet should be together.

4. *Ardhshalbhasna* : Chin to be kept on the floor, feet should be together. Fists of the hands kept along the body. One leg to be raised at a time, knees should be straight.
 5. *Shalbhasna* : Chin to be kept on the floor. Feet should be together. Hands inserted below the thighs to raise both the legs simultaneously. Knees should be straight.
 6. *Naukasana* : Hands to be stretched above the head. Feet should be together. Chin to be kept on the ground. Hands, chest, chin and legs should be raised off the ground. Hands to be stretched. The trunk and head raised forward and legs to be lifted backwards.
 7. *Dhanurasana* : To bend the legs at the knees slightly apart. Hands grip the ankle joints. Chin to be kept on the floor. Hands holding the ankle joints are to be stretched away from the trunk. Head can be raised later.
 8. *Magarasana* : Fingers interlocked and placed slightly in front of the chin. Feet should be together. One leg to be raised and crossed it over the other by giving a spinal twist. The face is then turned on the same side to which the leg is crossed. Elbows and shoulders should not be dislodged. Also read the description in 15.
- Postures on the back**
9. *Ardhhalasana* : Feet to be kept together in supine position. Hands to be kept by the sides. Palms to be placed on the floor. Head should be straight. a) to raise one leg at a time. b) to raise both the legs at a time at 90° above floor.
 10. *Halasana* : Same as 9 (b) and to proceed ahead beyond 90° angle without jerk and hands to be kept by the side.
 11. *Viparita karani* : To proceed beyond 90° as in 10. Get stabilised, then support the waist with the palms and to raise the legs upwards. Avoid fully straightening the legs. Abdomen should freely work to breathe.
 12. *Ardha-pavanmuktasana* : To bend the leg at the knee and to draw the leg close to the stomach and chest. To use the hands like a strap and tie the leg. Head to be lifted.
 13. *Pavanmuktasana* : Similar to 12. Here both the legs are drawn closer and knees should be held by the hand and pulled towards the body. Head and neck should be lifted forward towards the knees.
 14. *Magarasana* : Feet to be kept together. Fingers interlocked and palms placed below the neck. One leg to be raised and crossed it over the other. Face to be turned on the opposite side. Elbows and shoulders should not be raised. The leg through the hip-joint rotated as a whole as if travelling over the surface of a cone, the hip-joint being as if the vertex of the cone.
 15. *Naukasana* : a) Minimum-Hands are stretched above the head. The legs to be raised, hands also to be lifted just

an inch or two off the ground.
 b) Maximum-Hands on the thighs. The back and the legs to be raised maximum, but with a feel of balance. Both should be raised equally off the floor. Head can be loosened .

Postures in sitting

16. *Paschimottanasana* : Kneel on the floor. Feet kept together. Hands on the thighs. Keeping the neck fixed to bend forward freely and then to loosen the head through the neck. Hands just slide forward. Forehead should touch the floor. Further posterior stretch can be achieved by a pull by way of a good grip of the feet with the hands.

The Mudras

17. *Yoga-mudra* : Take a cross legged position or sit in *Vajrasana* i.e. sitting over the heels. Hold the hands at the back and bend forward keeping the neck fixed. After the bend is over, let the head be loosened through the neck to touch the floor. The feelings in this position should be marked.

18. *Bhrama-mudra* : One should sit in a comfortable position and let the head to take up six positions very slowly and maintain well i.e. forward, backward, and twisted left, right, lateral left and right.

Modification

To subject the head to a ball and socket movement in all directions once clockwise and then anti clock-wise.

The shuddhi-kiryas-cleansing process

19. *Kapalbhati* : This is to breathe out actively through the nose, making a quick abdominal movement inwards. The inhalation is passive. Whenever difficulty in abdomen (only) going in and air going out is observed, one should switch to simple blowing out through the mouth.

20. *Jala-neti* : To have a nasal wash with luke warm saline. Fit the nozzle into one nostril. Let the septum be horizontal. Start pouring saline from one nostril : It automatically is drained from the other. During the process use only the mouth to breathe. Do *kapalbhati* with alternate nostril also after this. At least 100 to 150 exhalations should be done in order to linger water drops. If nostril/nostrils are clogged, one should not try to force it open with active exhalation.

21. *Pranayama* : Sit comfortably upright. The technique is very close to the stage as in Sl. No. 1(f) as described in the technique of relaxation. Here too one breathes out slowly, smoothly, till the need to breathe in is felt, and similarly one starts breathing in slowly and smoothly till the need to breathe out is felt. The purpose of doing this for *Pranayama* is to realise or to be aware of the driving force or stimulus responsible for the act of inhalation and exhalation.

Posture in standing

22. *Samatasana* : One has to stand with the legs just a little apart and upright. Balance should be felt through the two legs. This can be used at times for relaxation.
23. *Hasta-padasana* : One should stand straight keeping the feet together. Neck to be fixed and freely bend forward through the spine/waist. Legs to be kept straight at the knees. Head should be loosened through the neck. Then bend forward as much as possible and floor to be touched by the fingers at last.
24. *Chakrasana* : One has to stand as in 23 and raise one hand up, palm towards the ear and hand sticking to the head. Then bend laterally to the side with the hands down. To begin with, the neck is fixed and later it is loosened. Legs should be straight at the knees.

PHYSIOLOGICAL PARAMETERS: (Supine resting)

Heart rate(HR), blood pressure (BP), skin temperature (Tsk) (arm, chest, thigh and calf) and oral temperature (Tor) were taken one hour after breakfast in the morning in supine position. HR and BP were taken by auscultatory method by stethoscope and sphygmomanometer respectively. Tsk was taken by YSI telethermometer and mean skin temperature was calculated from the Ramanathan's formula (25). Tor was taken by a precalibrated thermometer. Details of

procedure of recording these variables have been described elsewhere (10).

Body flexibility: Body flexibility was measured by Leighton's flexometer (15). Measurements of flexibility in degrees of angle for shoulder flexion/extension, trunk flexion/extension, hip flexion/extension, knee flexion/extension, trunk lateral flexion, hip abduction/adduction, neck rotation were taken.

Exercise test: After the recording of resting HR and oxygen consumption ($\dot{V}O_2$) the subjects pedalled in zero load on a bicycle ergometer. Then they were subjected to exercise protocol for graded work loads for 3 minutes duration in each work load. After 100 watt, it was increased by 20 watt in every minute until exhaustion or at HR of 185 ± 5 b.p.m. HR and $\dot{V}O_2$ were monitored by a HR monitor and $\dot{V}O_2$ measuring system of Morgan Exercise Test assembly. In another set of experimental protocol for exercise, the subjects pedalled on the bicycle ergometer at 70% of their maximal exercise capacity for 6 minutes. Before exercise, they took rest while sitting on the bicycle ergometer and had a warm up exercise for 2 minutes at zero load. After attaining a stable HR they pedalled for 6 minutes at 70% of their maximum exercise capacity.

Recordings of $\dot{V}O_2$ and HR were taken by Morgan Exercise test assembly, at rest, during exercise and during recovery for 10 minutes. Arterialised blood samples were taken at rest, just at the end of exercise and at 6th and 10th minute of recovery and analysed for lactate level in blood. Blood samples were taken by finger prick method and were analysed by Lactate analyser (Model 23L, YSI).

Psychological tests: The following tests were administered according to the procedures as described below:

Concentration: The test was designed on the pattern used by Eyesenck (28). A long series of numbers were read out to the subjects at the rate of one per second. Each series was suddenly interrupted at regular intervals and the subject was required to reproduce the last five digits read out to him, either in the reverse order (1st level) or any order (2nd level). The interruptions were randomised with a view to avoid any anticipatory gain by the subjects in recalling the digits. In all, there were ten trials in each testing condition and concentration scores for both the levels were computed by doubling the number of digits correctly reproduced. In each trial a new form of test was used to avoid facilitatory effects of previous recall.

Vigilance: Subjects were given paper sheets with stylised drawings of human faces having marks of eyes, mouth, tufts of hair and specs. It contained all the combinations of sober/laughing/weeping men or men with or without specs. The subjects had to tick a particular category from the assorted group of drawings within a specified time.

Anxiety and depression test: Anxiety and depression were tested by 'IPAT' anxiety (standardised on Indians) and 'IPAT' depression scale by Samuel and James respectively. Each test consisted 40 questions. Higher the score more were the anxiety and depression.

Subjective well being: To get a subjective view of the general feelings of the subjects they were given a questionnaire to answer about their general health, quality of sleep, mental condition, general feelings towards peers and superiors. A five point scale was made according to degrees of feelings either positive or negative. From 90 questions total score of subjective well being was calculated.

Statistical analysis was done by ANOVA for intragroup and by t-test for intergroup comparisons.

RESULTS

Parameters in resting conditions: Mean HR in the male subjects reduced significantly ($P < 0.01$) in both yoga and control group at the 3rd phase as compared to 1st phase (Table II). Female subjects also showed a

TABLE I: Physical characteristics the subjects.

Group	Sex	Age (yrs)	Height (cms)	Body weight (kgs)
Yoga (n = 23)	Male	23.60±0.51	169.30±1.21	55.50±1.84
Control (n = 21)		22.00±1.07	168.30±1.49	54.60±1.62
Yoga (n = 5)	Female	22.60±1.5	7.90±1.48	49.70±1.73
Control (n = 5)		22.80±0.58	156.40±2.82	50.00±2.53

Values are mean ± SEM

TABLE II: Supine resting parameters (Male).

Parameters	Control (n = 20)			Yoga (n = 23)		
	Phase I	Phase II	Phase III	Phase I	Phase II	Phase III
Heart rate (bpm)	74.85±1.606	75.45±2.035	69.55±1.736***	74.91±1.536	73.61±1.609	71.13±1.562***
Blood Pressure Systolic (mmHg)	113.70±2.033	110.50±1.582	104.95±1.113***	116.26±2.264	111.48±1.659	106.09±2.575***
Blood Pressure Diastolic (mmHg)	65.70±1.700	64.70±1.475	63.70±1.496	65.83±1.650	61.74±1.119**	63.04±1.165
Oral Temperature °C	37.17±0.039	37.08±0.057	36.86±0.064***	37.18±0.040	37.09±0.043*	36.98±0.035***
Skin Temperature °C	33.95±0.160	33.42±0.114**	33.43±0.115**	33.83±0.159	33.41±0.134*	33.63±0.136

Mean ± S.E.M. *P<0.05; **P<0.01; ***P<0.001.

TABLE III: Supine resting parameters (Female).

Parameters	Control (N = 5)			Yoga (N = 5)		
	Phase I	Phase II	Phase III	Phase I	Phase II	Phase III
Heart rate (bpm)	80.20±1.959	73.20±1.959	76.40±2.638*	77.60±1.806	70.20±3.839	73.60±3.108
Blood Pressure Systolic (mmHg)	116.40±4.915	110.40±4.069	108.00±3.633*	112.80±1.356	103.20±2.871**	101.60±0.979***
Blood Pressure Diastolic (mmHg)	74.00±4.000	75.20±5.314	69.60±3.868	70.80±3.666	67.20±5.426	61.60±3.311*
Oral Temperature °C	37.42±0.066	37.10±0.071**	37.08±0.087**	37.26±0.081	36.98±0.056**	37.04±0.048**
Skin Temperature °C	32.90±0.134	32.54±0.264	32.78±0.143	33.90±0.281	32.52±0.143***	32.94±0.108**

Mean ± S.E.M. *P<0.05; **P<0.01; ***P<0.001.

similar reduction in heart rate but it was in a lower level of statistical significance (Table III). Systolic BP (SBP) decreased significantly ($P<0.001$) in both the groups of male subjects only at the 3rd phase. Females showed a significant reduction in SBP ($P<0.01$) only in the yoga group at the 2nd phase as compared to the 1st phase and at the 3rd phase both the groups showed significant reduction. Both the male and female subjects in the yoga group showed a reduced value of mean diastolic BP (DBP) at the 2nd phase as compared to the 1st phase (Table II & III). It was significantly lower ($P<0.01$) in the male subjects in the yoga group at the 2nd phase

as compared to the 1st phase but same did not happen in the control group who did not practice yogic exercises in the 1st 5 months. In females there was significant reduction ($P<0.05$) in DBP in the yoga group in phase-3 as compared to phase-1, but control group did not show this. Tor showed significant reduction ($P<0.001$) in both the groups at the 3rd phase among the male subjects. There was a significant reduction ($P<0.05$) in the male-yoga group at the 2nd phase but control-male did not show this. Both yoga and control group, among the females showed significant reduction ($P<0.01$) in Tor at the 2nd and 3rd phase. Both the groups among the male subjects

showed a significant drop in Tsk at the 2nd phase with respect to 1st phase. At the 3rd phase control group showed the significant drop ($P<0.01$) but yoga group did not show this. In females, only yoga group showed significant drop at the 2nd phase ($P<0.01$) and 3rd phase ($P<0.01$) as compared to the 1st phase and the control group did not show this.

Body flexibility: The male subjects of the yoga group showed significant improvement in shoulder flexion/extension values at the 2nd ($P<0.001$) and 3rd ($P<0.01$) phase. Male control group also showed improvement at the 3rd phase only (Table IV). Trunk flexibility improved significantly ($P<0.001$) at the 2nd phase in yoga group. Trunk lateral flexibility also improved significantly ($P<0.001$) at 3rd phase in the yoga group, but in the control group improvement ($P<0.01$) was observed only at the 3rd phase. Hip flexibility improved significantly

($P<0.001$) at the 2nd and 3rd phase in the yoga group and at the 3rd phase in control group. In the male subjects in intergroup comparisons knee flexion/extension values were significantly ($P<0.05$) higher in yoga group as compared to the control group in the phase-2 and 3. Neck rotation also showed significantly higher values at the 2nd and 3rd phase i.e. ($P<0.001$) & ($P<0.05$) respectively.

In females (Table V) shoulder flexion/extension values were significantly lower in phase-2 ($P<0.01$) and higher in phase-3 ($P<0.001$) as compared to phase-1 and phase-2 respectively in the yoga group. Trunk flexibility improved significantly ($P<0.05$) at the 3rd phase as compared to the 1st phase in both the groups. Knee flexion/extension values were also higher ($P<0.05$) in the 3rd phase as compared to the 2nd phase in the yoga group.

TABLE IV: Flexibility (Male), (degrees of angle).

Parameters	Control Group Phase			Yoga Group Phase		
	I	II	III	I	II	III
Shoulder Flexion Extension	202.9±3.49	202.2±3.75	206.3±3.64**	210.3±3.25	217.0±3.23***	215.4±2.73**
Trunk Flexibility	67.8±2.03	68.0±2.17	68.5±2.18	66.2±2.21	71.0±2.15***	66.9±1.75
Trunk Lateral Flexion	94.4±1.22	95.0±1.29	98.0±1.85**	98.7±2.13	102.4±2.09*	104.4±1.79***
Hip Flexion/Extension	79.1±2.27	80.8±2.12	86.9±1.66***	75.2±1.86	85.2±1.15***	85.9±1.58***
Hip Adduction/Abduction	48.4±1.57	46.0±1.03	47.4±1.18	54.0±1.50	54.9±1.48	54.7±1.60
Knee Flexion/Extension	149.2±1.37	148.6±1.61	149.0±1.16	154.2±2.02	155.9±2.21*	155.0±2.34*
Neck Rotation	167.7±3.01	167.2±2.62	171.2±1.70	161.7±2.29	165.7±2.27**	165.4±2.02*

Hip adduction/abduction, III Phase

Values are Mean ± SEM (yoga vs control $P<0.001$)

* $P<0.01$ yoga vs control

* $P<0.05$; ** $P<0.01$; *** $P<0.001$.

TABLE V: Flexibility (Female). (Degrees of angle).

Parameters	Control Group Phase			Yoga Group Phase		
	I	II	III	I	II	III
Shoulder Flexion/Extension	188.6±9.026	192.6±4.320	197.8±2.010	201.2±3.337	198.2±2.739	205.0±2.73
Trunk Flexibility	50.6±7.387	51.6±8.004	55.6±6.145	53.2±4.224	62.6±4.976	60.0±5.167
Trunk Lateral Flexion	106.4±8.733	108.2±6.200	113.0±5.385	113.4±5.016	110.1±4.669	116.2±5.71
Hip Flexion/Extension	96.2±9.410	101.0±9.844	97.2±7.860	91.0±1.871	95.2±1.463	93.8±1.854
Hip Adduction/Abduction	44.4±3.203	39.2±3.839	45.4±3.187	47.4±2.227	45.6±4.781	46.2±0.800
Knee Flexion/Extension	144.0±5.639	153.2±3.652	158.8±4.329	150.2±5.190	157.8±3.800	155.8±2.200
Neck Rotation	164.2±2.850	167.8±7.430	178.4±2.249	169.±.047	176.2±1.158	166.8±4.042

Values are Mean ± SEM *P<0.05

Responses in exercise: As shown in Table VI heart rate values at rest and exercise reduced significantly in both the groups at

the 3rd phase as compared to the 2nd phase. Oxygen consumption values were significantly higher (P<0.001) in the control

TABLE VI: Physiological parameters during sub maximal exercise in Yoga (Y) and Control (C) groups. (MEAN ± SEM)

Parameters	Group	Rest		Exercise				Recovery			
		Phase		3 min Phase		6 min Phase		5 min Phase		10 min Phase	
		II	III	II	III	II	III	II	III	II	III
Heart rate (bpm)	Y	86.00 1.909	79.42** 1.709	154.95 3.151	146.89** 2.616	169.63 4.065	160.89 4.416	112.16 3.740	106.32 3.427	104.58 2.721	103.05* 2.941
	C	83.62 1.945	76.00** 2.288	154.19 2.970	145.12 2.762	167.69 3.048	157.81 3.852	109.44 3.434	96.62 3.436	103.56 2.306	93.62 3.133
Ventilation VE (L/min. BTPS)	Y	7.25 0.273	8.20* 0.328	38.84 1.264	38.00* 1.418	45.67 1.457	42.51 1.572	11.77 0.447	12.89* 0.550	9.40 0.273	10.79** 0.351
	C	7.82 0.375	8.75 0.512	38.64 1.210	37.42 1.355	43.01 2.245	42.36 1.815	11.29 0.602	12.78 0.527	8.99 0.445	11.09*** 0.478
Oxygen Consumption Vo ₂ ml/kg/min	Y	4.03 0.197	4.88** 0.142	24.82+ 0.757	25.97 0.789	28.09 0.932	27.18 0.851	5.43 0.209	5.98* 0.190	4.99 0.165	5.87*** 0.179
	C	4.08 0.117	5.09** 0.265	24.85 0.665	25.71 0.602	26.84 0.725	27.43*** 0.777	5.48+ 0.220	5.91 0.260	4.49 0.145	5.40* 0.157
Oxygen Pulse O ₂ P (ml)	Y	2.51 0.144	3.26*** 0.105	8.92* 0.323	9.45* 0.264	9.01 0.321	9.14 0.261	2.64 0.096	3.07** 0.151	2.58 0.094	3.08*** 0.119
	C	2.57 0.085	3.66*** 0.157	8.87 0.297	9.76 0.417	8.80 0.292	9.39 0.440	2.58 0.087	3.68** 0.270	2.52 0.085	3.41*** 0.155
Ventilation Equivalent for Oxygen (ml)	Y	26.59 0.679	25.81 0.782	232.89 0.326	22.22* 0.697	23.80 0.397	23.34 0.709	31.24 0.782	32.33 0.954	27.67 0.636	27.98 0.865
	C	28.76 1.162	28.57 1.247	22.32 0.762	21.99 0.0.697	23.37 0.912	23.33 0.550	31.79 1.362	32.17 1.240	28.14 0.890	28.71 1.125

Yoga (N = 19), Control (N = 16), + Y vs C (P<0.05); *P<0.05; **P<0.01; ***P<0.001.

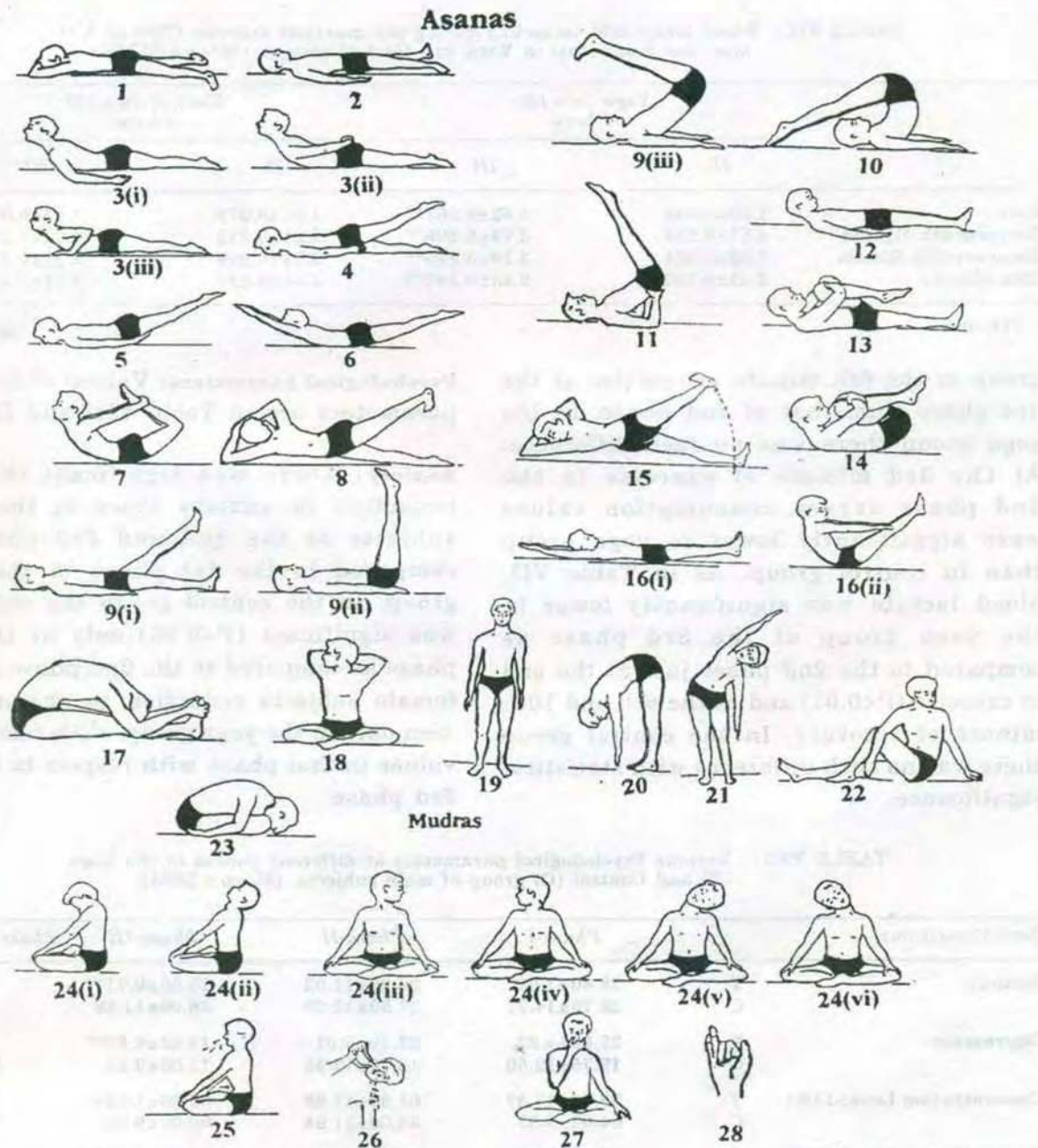


Fig. I: 1. Makarasana 2. Shavasana 3. (i) Sahaj Bhujangasana 3. (ii) Modified Bhujangasana 3. (iii) Paramparika Bhujangasana 4. Ardhashlabhasana 5. Shalabhasana 6. Naukasana 7. Dhanurasana 8. Magarasana (on chest) 9. (i) Ardhahalasana 9. (ii) Arhahalasana 9. (iii) Halasana 10. Halasana 11. Viprita-karni 13. Ardhapavanmuktasana 14. Pavanmuktasana 15. Magarasana (on back) 16. (i) Naukasana-minimum 16. (ii) Naukasana-maximum 17. Paschimottasana 18. Twist in sitting 19. Samatasana 20. hastapadasana 21. Chakrasana 22. Vakarasana 23. Yogamudra 24. (i) Brahmamudra-1 24. (ii) Brahmamudra-2 24. (iii) Brahmamudra-3 24. (iv) Brahmamudra-4 24. (v) Brahmamudra-5 24. (vi) Brahmamudra-6 25. Kapalbhati 26. Jalaneti 27. Pranayama-anulom-vilom 28. The way fingers of the right hand are kept for anulom-vilom.

TABLE VII: Blood lactic acid (m mol/L) during sub-maximal exercise (70% of $\dot{V}O_{2\max}$ for 6 minutes) in Yoga and Control groups. (Mean \pm SEM).

	Yoga (n = 16) Phase		Control (n = 16) Phase	
	II	III	II	III
Rest	1.89 \pm 0.043	1.62 \pm 0.067**	1.90 \pm 0.074	1.73 \pm 0.079
Exercise 6th Minute	4.57 \pm 0.254	3.74 \pm 0.208**	4.24 \pm 0.313	4.02 \pm 0.248
Recovery 6th Minute	3.92 \pm 0.224	3.16 \pm 0.220**	3.59 \pm 0.294	3.25 \pm 0.257
10th Minute	3.43 \pm 0.190	2.45 \pm 0.197**	2.94 \pm 0.227	2.71 \pm 0.237

**P<0.01

group at the 6th minute of exercise at the 3rd phase than that of 2nd phase. In the yoga group there was no such difference. At the 3rd minute of exercise in the 2nd phase oxygen consumption values were significantly lower in yoga group than in control group. As in Table VII, blood lactate was significantly lower in the yoga group at the 3rd phase as compared to the 2nd phase just at the end of exercise (P<0.01) and at the 6th and 10th minute of recovery. In the control group there was no such difference with statistical significance.

Psychological parameters: Values of different parameters are in Table VIII and IX.

Anxiety: There was significant (P<0.01) reduction in anxiety score in the male subjects at the 2nd and 3rd phase as compared to the 1st phase in the yoga group. In the control group the reduction was significant (P<0.05) only at the 3rd phase as compared to the 2nd phase. In the female subjects reduction in anxiety was seen only in the yoga group while comparing values in 2nd phase with respect to that of 3rd phase.

TABLE VIII: Various Psychological parameters at different phases in the Yoga (Y) and Control (C) group of male subjects. (Mean \pm SEM).

Test / Conditions		Phase-I	Phase-II	Phase-III	Phase-II vs III
Anxiety	Y	28.40 \pm 7.92	29.20 \pm 11.03	25.60 \pm 9.71**	**
	C	28.75 \pm 14.27	27.50 \pm 12.23	26.00 \pm 11.88	*
Depression	Y	25.60 \pm 4.92	22.20 \pm 6.01	19.40 \pm 6.87**	*
	C	19.75 \pm 12.50	18.75 \pm 12.31	18.00 \pm 9.34	NS
Concentration Level-I (%)	Y	59.60 \pm 13.37	61.80 \pm 13.38	69.80 \pm 13.34*	**
	C	64.00 \pm 9.93	65.00 \pm 11.94	66.00 \pm 9.93	NS
Concentration Level-II (%)	Y	79.60 \pm 4.77	83.20 \pm 6.72	86.00 \pm 5.47***	**
	C	74.50 \pm 10.11	74.50 \pm 12.79	76.50 \pm 12.04	NS
Vigilance	Y	175.80 \pm 16.36***	179.00 \pm 18.82	188.40 \pm 18.52	***
	C	167.75 \pm 18.35	169.25 \pm 12.03	171.50 \pm 12.21	NS
Subjective well being	Y	-	98.4 \pm 12.72	106.6 \pm 12.17	*
	C	-	101.75 \pm 12.55	105.0 \pm 8.52	

Yoga (n = 23), Control (n = 21) *P<0.05; **P<0.01, ***P<0.001.

TABLE IX: Various Psychological parameters at different phases in the Yoga (Y) and Control (C) group of female subjects, (Mean \pm SEM.)

Test/Conditions		Phase-I	Phase-II	Phase-III	Phase-II vs III
Anxiety	Y	30.47 \pm 12.85	31.30 \pm 11.65	26.39 \pm 11.84*	*
	C	28.80 \pm 10.72	28.57 \pm 11.81	25.00 \pm 10.38	NS
Depression	Y	24.73 \pm 10.68	24.56 \pm 11.11	19.34 \pm 9.22**	NS
	C	20.85 \pm 9.98	21.14 \pm 9.29	19.19 \pm 8.47	NS
Concentration Level-I (%)	Y	54.17 \pm 8.96	55.91 \pm 9.69	60.17 \pm 8.71*	*
	C	52.28 \pm 11.47	54.00 \pm 12.99	57.52 \pm 10.95	
Concentration Level-II (%)	Y	72.52 \pm 9.26	74.00 \pm 10.53*	78.86 \pm 8.98*	
	C	74.42 \pm 9.20	75.33 \pm 9.28	76.19 \pm 8.17	
Vigilance/min.	Y	153.73 \pm 35.24	158.91 \pm 30.11	172.73 \pm 32.81***	*
	C	141.61 \pm 29.67	141.61 \pm 22.26	144.57 \pm 22.99	
Subjective well being	Y	-	100.0 \pm 11.44	106.6 \pm 8.16	*
	C	-	99.04 \pm 9.65	101.33 \pm 12.14	NS

Yoga (n = 5), Control (n = 4) *P<0.05; **P<0.01; ***P<0.001.

Depression: Depression also showed significant reduction (P<0.01) in both male and female subjects at the 3rd phase as compared to the 1st phase. In the comparison between 2nd phase and the 3rd phase, there was reduction with significant difference (P<0.05) in male yoga group but not in the same females.

Concentration level I: It improved significantly at the 3rd phase in both male (P<0.01) and female (P<0.05) subjects.

Concentration level II: It improved significantly at the 3rd phase in both male (P<0.001) and female (P<0.05) subjects only in the yoga group.

Vigilance: There was significant improvement in vigilance score in both the male (P<0.01) and female (P<0.01) subjects at the 3rd phase in the yoga group.

Subjective well being: It was significantly better in the yoga group of both male

(P<0.01) and female (P<0.05) subjects in the 3rd phase as compared to the 2nd phase.

DISCUSSION

The resting HR, BP and Tor showed reduction in both yoga and control groups at the 2nd and 3rd phase showing thereby a relatively reduced sympathetic tone in all the subjects at the later part of their stay at Training Institute, as compared to the initial days. The subjects probably were anxious to settle in the new work/training environment and to cope with the busy schedule of the course on the initial days which might have brought about these changes. At the later stage (5th or 10th month) the relatively higher sympathetic tone reduced gradually resulting in a reduction in the values of different parameters. The increase in plasma cholinesterase level for 5th and 10th month in all the groups also supports this (our unpublished observation). Yoga group showed comparatively lower level of

sympathetic activity as compared to the control group as it was evident in significantly lower DBP at the 5th and 10th month of training as compared to the before training values in the male subjects. Similarly in the female subjects SBP reduced significantly at the 5th month in the yoga group. At the 10th month, control group along with the yoga group also showed significant reduction in SBP as they also did yogic exercises at the later half of training period. In the male yoga group Tor reduced significantly at the 5th month but male control group did not show such significant fall during this period. At the 10th month both the groups showed the fall. This was again due to the yogic exercises practiced by the control group after the 5th month. Tsk values showed greater drop at the 10th month in the control group than in the yoga group, thus showing a greater peripheral vasoconstriction in the control group and lower level of vasoconstriction and sympathetic activity in the yoga group. The female subjects showed similar type of autonomic nervous responses like their male counterparts but in certain cases it was different and inferences drawn on this basis would be misleading as number of subjects in each group of the female subjects was less (5 only).

Flexibility: In the male subjects, shoulder, trunk, hip and neck flexibility increased significantly after the 5th month of yogic practices and it increased further at the 10th month. As the control group started yogic exercise towards the middle of the training period, there was improvement at the 10th month in their case and they had improvement in the flexibility of the shoulder, trunk, and hip joints during that

period. Females did not show improvement in flexibility like males. The improvement in flexibility parameters was also seen earlier by us in the middle aged men after six months training in Hatha Yogic exercises (15). Improvement in body flexibility was observed in the range of motion of various joints of the body. Yogic asanas are almost similar to the static stretching exercises which are used to improve the range of motion alongwith the conventional calisthenic exercise. This kind of exercise helps to utilize the inverse myotatic reflex.

Exercise: The reduction in heart rate in both the groups of subjects at the 5th and 10th months in submaximal exercise showed that, they could perform the same work with a comparatively lower HR. The control group did not perform the yogic exercise during initial 5 months of training but some of them used to do jogging and participated in outdoor games often during this period. So, they have shown the lower level of HR in exercise at the 5th month like the yoga group, for whom it might be the yogic exercises which helped to achieve this. After the 5th month, control group also performed the yogic practices and they showed further reduction in exercise HR at the 10th month alongwith yoga group. This indicated that the yoga group could maintain the physical efficiency like the mixed group (as in this case the control group, where both types of exercises i.e. yoga and other form of physical exercise were performed by the subjects). There was significant increase in $\dot{V}O_2$ at the 10th month in submaximal exercise (6th minute) in the control group with respect to their values of corresponding work load at the 5th month of training

period. Yoga group did not show this. So yoga group performed the same work without increasing oxygen consumption like control group. The improvement in physical efficiency and lesser fatigue in the yoga group had been further reflected in the blood lactate values which showed significantly lower values. The recovery blood lactate values after submaximal exercise for 6 min at 70% of $\dot{V}O_2$ Max also were lower in the yoga group at 10th month with respect to that of 5th month. The recovery of blood lactate level after exercise was also faster in the yoga group (table 7). This may be possible by the shift of anaerobic threshold at higher work load and it has also been observed by this study. Maximal oxygen uptake capacity has not increased in yoga group in this study (29). The yogic exercises being low intensity physical exercise and being quite different from other kinds of conventional exercises could improve anaerobic threshold rather than aerobic capacity.

Psychological parameters: To get clear insight into the personality of the subjects, that classify individuals according to the coping reserves for facing day to day stresses in the job environment where more of psychological component of stress was involved as in this situation, tests to evaluate the anxiety and depression were administered. The yoga group showed less anxiety and depression at various stages and control group showed this reduction only after 2nd half of the training period. So, the yogic practices helped the subjects to reduce the anxiety and depression. It was being observed that the beneficial effects of yoga was predominant at the 10th month, showing that a comparatively longer

period of yogic practices were required for improvement in personality. Any psychological stress is likely to affect mental and psychomotor performance which results in a reduced work efficiency. Literature on yoga and our previous studies indicated improvement in various psychomotor and cognitive functions by yogic exercises (17). So, to assess this aspect, objective tests of measuring concentration, learning, memory, arithmetic ability, vigilance, perceptual efficiency and reaction time were conducted. Only the values of concentration and vigilance are shown in this paper. All the cognitive functions showed an improvement in the yoga group. While performing the yogic asanas the individuals were instructed to be fully conscious for each and every movement along with the movements due to breathing. Instructions were given for an effort to perform the asanas in a relaxed and easy manner without any stress or jerky movement. The proprioceptive involvement in a well co-ordinated fashion with mentally relaxed state in the yogic practices helped the subjects to achieve the improvement of aforementioned psychological and psychomotor components. Work of Telles, 1993 (14) and Madanmohan, 1992 (21) supports the present findings. The improvement in various physiological and psychological functions, improved the feeling of mental well being which was evident from the subjective comments from the subjects with significant improvement in the yoga group.

In general, yogic exercises as practised by the trainees have helped them to improve various physiological functions like improvement in efficiency in submaximal exercise and body flexibility. The improvement in psychological parameters

were very prominent among the subjects who practiced yogic exercises.

ACKNOWLEDGEMENTS

The study was conducted under the auspices of DRDO, Ministry of defence. We express our sincere thanks to Dr. V. K. Aatre, Scientific Advisor to Raksha Mantri for his keen interest and encouragement for the study. It is a great pleasure to acknowledge the sincere help and logistical support rendered by Director and other officers and staff of IAT, PUNE. We are indebted to the 8th EFC and MEFC trainees

in IAT, who were the subjects for the study and volunteered to undergo different tests in spite of their busy schedule. We also express our sincere thanks to Wg. Cdr. P. Bandopadhyaya and Dr. A.Salhan, Sc'D' for valuable advice in some critical phases and giving the medical cover during the studies. Thanks are due to Sh.S.K.S Chauhan, SSA for his technical assistance. We acknowledge the help rendered by Uday Pendse, yoga Instructor and his two team members from Uday Institute of Yoga,Pune, who regularly trained our subjects in the different yogic practices with utmost care.

REFERENCES

- Anand BK, Chinna GS, Singh B. Studies on Shri Ramanand Yogi during his stay in an air tight box. *Ind J Med Res* 1961; 49: 82-89.
- Anand BK and Chinna GS. Investigations on yogic claiming to stop their heart beats. *Ind J Med Res* 1961; 49: 90-94.
- Wallace RK. Physiological effects of Transcendental meditation. *Science* 1970; 167: 1751-1754.
- Benson H, Lehamann JW, Malhotra MS, Goldman RF, Hopkins J, Epstein MD. Body temperature changes during the practice of g. Tum-mo yoga. *Nature* 1982; 295: 234-236
- Wallace RK. et al. A wakeful hypometabolic physiologic state. *Am J Physiology* 1971; 221 (3): 795-799
- Wenger MA, Bagchi BK. Studies of Autonomic functions in practitioners of yoga in India. *Behavioral Science* 1961; 6: 312-323.
- Wenger Experiments in India on voluntary control of the heart and pulse. *Circulation* 24: 1319-1325.
- Udupa KN, Singh RH, Yadav R.A. Certain studies on psychological and biochemical responses to the practice Hatha yoga in normal volunteers. *Ind J Med Res* 1973; 61: 237-244.
- Udupa KN, Singh RH, Settiwar RM. Physiological and biochemical studies on the effect of yoga and certain other exercises. *Ind J Med Res* 1975; 63: 620-625.
- Selvamurthy W, Nayar HS, Joseph NT, Joseph S. Physiological effects of yogic exercises. *NIMHANS Journal* 1983; 1: 71-80.
- Joseph S, Sridhharan K, Patil SKB, Kumaria ML, Selvamurthy W, Joseph NT, Nayar HS. Study of some physiological and biochemical parameters in subjects undergoing yogic training. *Ind J Med Res* 1981; 74: 120-124
- Mayol J. Yoga aids in a record dive. *Life* 1981; 41: 74-75.
- Meti BL. Electrophysiology of Pranayama and Meditation. *Indian J Physiol Pharmacol* 1994; 38: 46 (supplement).
- Telles S, Hanumanthaiah B, Nagarathna R, Nagendra HR. Improvement in static motor performance following yogic training of school children. *Perceptual and Motor skills* 1993; 76: 1-3.
- Ray US, Hegde KS, Selvamurthy W. Effects of yogic Asanas and physical exercises on body flexibility in middle aged men. *The yoga Review* 1983; 3 (2): 75-79.
- Ray US, Hegde KS, Selvamurthy W. Improvement in muscular efficiency as related to a standard task after yogic exercises in middle aged men. *Indian J Med Res* 1986; 83: 343-348.
- Selvamurthy W. et al. Effects of yogic exercises on middle aged persons. *DIPAS Report No. 3/84, Project RD* 1984; P1-92/DIP-112.

18. Selvamurthy W, Purkayastha SS, Ray US et. al Effects of yogic exercises on acclimatization to High Altitude and amelioration to altitude illness. *Ministry of Defence, Project No. RD 1990; P1-86/ DIP-172.*
19. Selvamurthy W, Ray US, Hegde KS, Sharma RP. Physiological responses to cold (10 degree centigrade) in men after six months practice of yogic exercises. *Int J Biometeorol* 1980; 12: 188.
20. Selvamurthy W, Sridharan K, Ray US, Tiwary RS, Hegde KS, Radhakrishnan U, Sinha KC. A New physiological approach to control essential hypertension. *Indian J Physiol Pharmacol* 1998; 36: 229-233.
21. Madanmohan, Thombre DP, Balakumar B, Nam Sinyan. Effect of yoga training on reaction time, respiratory endurance and muscle strength. *Indian J Physiol Pharmacol* 1992; 36: 229-233.
22. Telles S, Nagarathna R, Nagendra HR, Desiraju T. Alterations in auditory evoked potentials during meditation on a meaningful symbol-"OM". *Int J Neurosci* 1994; 76: 87-94.
23. Telles S, Desiraju T. Autonomic changes in Brahmakumari's Raja yoga Meditation. *Int J Psychophysiol* 1993; 1: 147-152.
24. Colligan MJ. Mass Psychogenic illness: Some clarifications and Perspectives. *J Occupa Med* 1993; 23: 636.
25. Ramanathan NL. A new weighing system for mean surface temperature of human body. *J Appl Physiol* 1964; 19: 531-533.
26. Kuvlayanand Swami. *Asanas. Kaivalyadhana, Lonavala, Pune, India, 1982.*
27. Satyananda Saraswati. *Asanas, Pranayama, Mudra, Bandha*(7th Ed), Bihar School of Yoga, Monghyr, Bihar, India, 1989.
28. Eysenck HJ. *The Scientific Study of Personality* (London: ROUTLEDGE & KEGAN PAUL) 1952.
29. Ray US, Purkayastha SS, Mukhopadhyay S, Gopinathan PM, Satija NK, Asnani V, Tomer OS, Thakur L, Prashad R, Vij A. Effect of yogic exercises on electronic fellowship trainees in improving health and efficiency. *DIPAS, DRDO, Min. of Defence, Govt. of India. Report No. DIPAS/ 1/95 1995.*