Tolerance to Aviation Stresses after Yogic Exercise – A Psychophysiological Evaluation

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Abstract

A STUDY on the effects of some yogic exercises on psycho-physiological functioning and tolerance to aviation stresses on six healthy, well motivated subjects in the age group of 33–40 years was carried out. After a period of twenty weeks, a statistically significant reduction in heart rate and rise in alpha index were found. Reduction in systolic/diastolic blood pressure and weight were also noticed though not significant. Two subjects whose baseline ECG had shown low amplitude of T wave in the lateral precordial leads showed return of T to normal amplitude. There was a suggestion of more effective thermoregulation under severe heat stress. Performance on perceptual speed test and Flight Oriented Psychomotor test showed improvement.

Introduction

Stress endangers the psychophysiological equilibrium of the individual[5]. Yoga has been considered as a means to attain and maintain this equilibrium[11]. In aviation, individuals are constantly exposed to various external and internal stresses with severe physiological and psychological demands placed on them. It has been reported that static exercises that may be more useful in enhancing tolerance to aviation stresses as compared to endurance training which increases incidence of syncope[7-12]. However, no study has yet been undertaken, employing yogic exercises as a stress reducing agent in aviation. In the present study it is intended to find out whether or not yogic exercises bring about any psycho-physiological changes in the individual towards better adjustment to aviation stresses. This preliminary report is after 20 weeks of yoga training.

Material and Methods

Six healthy well motivated volunteers in the age group of 33–40 years (mean age 37.3 yrs) were taken for this study. Before starting the study, their general and systemic examination was carried out. Their baseline parameters which were recorded in the morning at about 0745 hrs before starting the day's routine work included the following;

- (i) Pulse & B. P.
- (ii) ECG — 12 lead
- (iii) EEG — 16 Channel
- (iv) Pulmonary function tests.
- (v) 70° Head up Tilt (HUT) table studies to assess orthostatic tolerance.
- (vi) Exposure to heat stress (Oxford Index 38.7°C) in the IAM Hot Cockpit to assess effect of yoga on thermoregulation.
- (vii) Perceptual speed test to assess the speed of perception of a complex detail.
- (viii) Wechsler memory scale — a composite memory test.
- (ix) Flight oriented psychomotor test — performance of this test involves comprehension, short term memory and gross psychomotor coordination.

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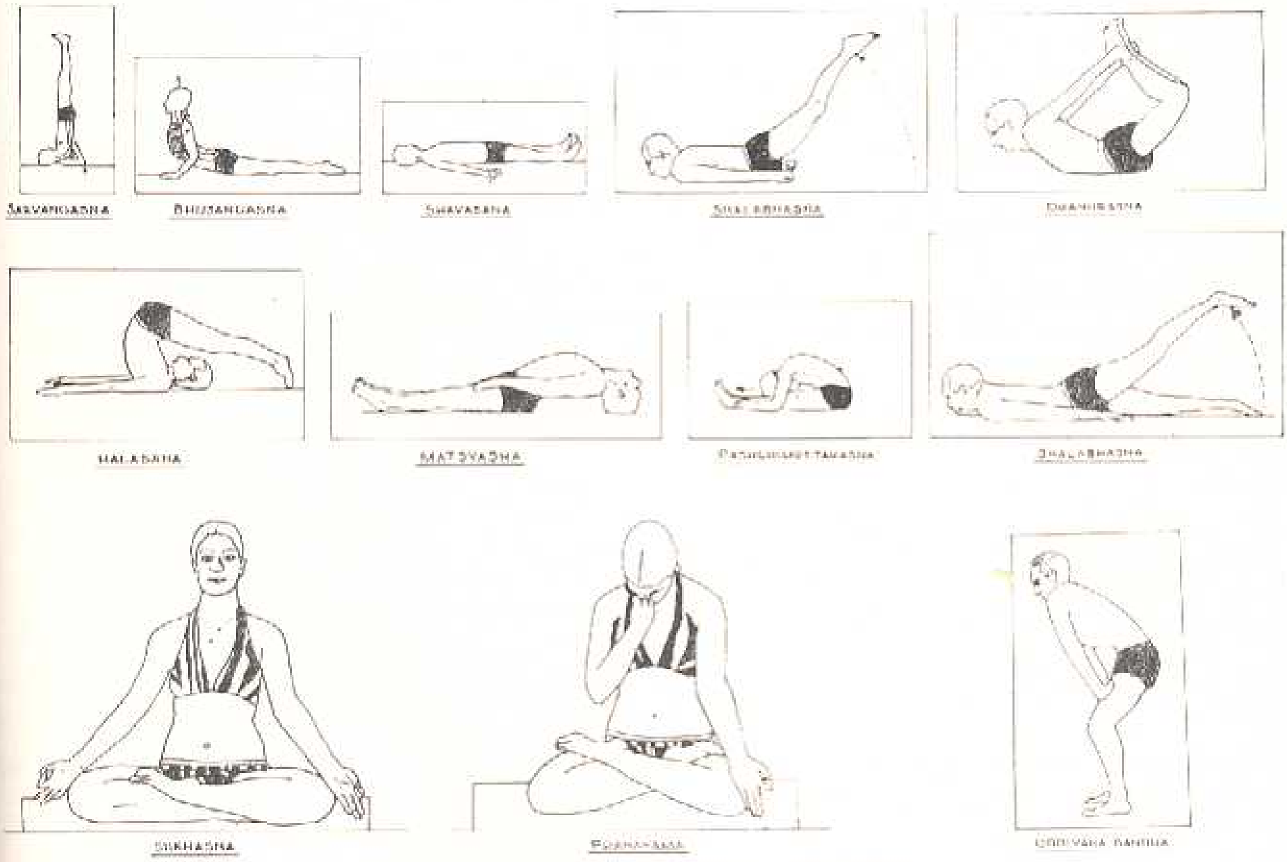

Fig. 1 The yoga asanas practised by the subjects

(x) Flicker Fusion Frequency—this is an index of the subject's psychophysiological state.

(xi) 16 PF Test—it is an objective personality test where subject's total personality profile is drawn on sixteen primary traits.

On obtaining the baseline records, the subjects were introduced to yogic exercises which were given for a duration of half an hour daily by the first author who has undergone a formal training in yoga.

The following asanas (Fig.1) in sequential order were employed as yogic exercises and were given for about half an hour daily :—

(i) Sarvangasana
(ii) Halasana
(iii) Matsyasana
(iv) Paschimottasana
(v) Bhujangasana
(vi) Shalabhasana
(vii) Dhanurasana
(viii) Uddiyana Bandha
(ix) Pranayama
(x) Shavasana
(xi) Sukhasana

The subjects were assessed on the above mentioned psychophysiological parameters which were recorded at approximately the same time of the day after seven and twenty weeks of yogic exercises.

Results

The effect of yoga on physiological parameters is given in Tables I & II while the response to whole body heating at 57°DB and 35.5°WB (Oxford Index 38.7°C) is tabulated in Table III.

The respiratory function parameters are shown in Table IV. Statistical analysis has not shown any significant difference in pre and post yoga results.

TABLE I

Physiological Parameters (a)

	Heart Rate			Systolic BP			Diastolic BP		
	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 Weeks of Yoga	After 20 weeks of Yoga
SPD	64	64	—	120	120	—	78	72	—
MBD	72	70	70	110	110	106	70	60	66
JMW	84	76	58	140	132	110	80	74	70
EMI	78	72	57	124	120	120	80	80	78
TBB	68	62	60	130	114	120	66	66	76
YN	66	60	55	116	110	142	80	72	84
Mean	72	67.3	60	123.3	117.7	119.6	75.7	70.7	75.8
SD	7.7	6.3	5.9	10.6	8.3	14.0	6.1	6.9	8.8
Mean diff. from Before Yoga		—4.7	—12		—5.6	—3.7		—5.0	0.1
Significance		$P<0.05$	$P<0.05$		NS	NS		$P<0.05$	NS

TABLE II

Physiological Parameters (b)

	Resting Electrocardiogram (Twaves)		Weight In Kgs			Alpha Index		
	Before Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga
SPD	—	—	62.5	60.5	—	67.2	77.5	—
MBD	Low amplitude V_4 — V_6	NAD	64	64	65.2	35.1	43.8	60
JMW	Low amplitude V_4 — V_6	NAD	63	60	60	75.0	88.0	90
EMI	NAD	NAD	65	63	62.2	45.8	62.6	72
TBB	NAD	NAD	74	68	70	95	98	96
YN	NAD	NAD	53	53	55	12.2	18.5	56
Mean			63.6	61.4	60.5	55.1	64.7	74.8
SD			6.7	5	6.2	29.9	27.1	15.9
Mean diff. from Before Yoga				-2.2	-3.1		+9.6	19.7
Significance				NS	NS		$P<0.05$	$P<0.05$

TABLE III

Effects of Yoga on Physiological Responses to Heat Stress
(57°DB & 35.5°WB)

	Rise in mean body temperature °C			Rise in Heart rate/Min			Sweat loss in gms/M² BSA		
	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga
MBD	2.82	1.77	2.0	58	44	48	527	542	701
JMW	2.90	2.10	2.3	26	40	34	431	516	600
EMI	2.46	2.91	2.8	48	24	40	440	341	300
TBB	3.53	2.73	3.2	42	28	30	287	319	507
YN	3.23	2.20	1.30	42	28	44	616	437	470
Mean	2.98	2.34	2.32	43.2	32.8	39.2	460.2	431	515.6
± SD	0.38	0.45	0.73	11.6	8.7	7.3	122.5	100.3	150.1
Mean diff. from Before Yoga		– 0.66	– 0.64		– 10.4	– 4.0		– 29.2	+ 55.4
Significance		NS	NS		NS	NS		NS	NS

TABLE IV

Pulmonary Function Tests

	FVC		FEVI		FEVI/FVC (%)		MVV		FMF		FEF	
	Before Yoga	After Yoga	Before Yoga	After Yoga	Before Yoga	After Yoga	Before Yoga	After Yoga	Before Yoga	After Yoga	Before Yoga	After Yoga
MED	4452	4499	3657	3686	82	81	137	138	200	217	595	569
JMW	4134	4480	3710	3507	89	78	139	131	296	230	400	430
EMI	4558	4661	3498	2927	76	62	131	110	156	141	530	379
TBB	3127	3252	2597	2710	83	83	97	102	180	163	360	401
Mean	4068	4223	3366	3208	82.5	76.0	126	120	208	188	471	445
± SD	652	652	520	464	5.3	9.6	20	17	61	43	110	85
Mean diff.		155		– 158		– 6.5		– 6		– 20		– 26
Significance		NS		NS		NS		NS		NS		NS

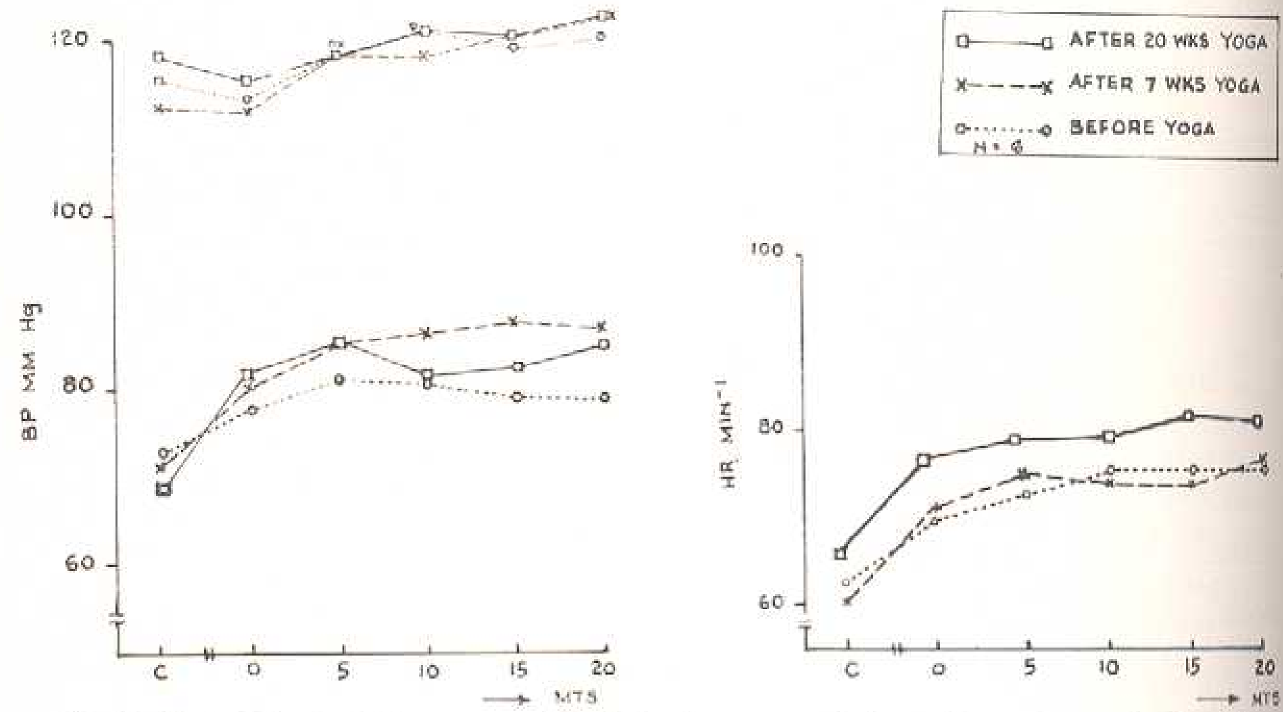

Fig 2. Effect of Yoga on CVS responses to 70° HUT. There was no significant difference between the 3 conditions

The responses of the subjects (N = 6) to 70°HUT is depicted in Fig 2. A statistical comparison of the values at each one of the points by a paired test for the before and after yoga states did not reveal any significant differences ($P > 0.05$).

Results of performance on psychological tests before and after yogic training are indicated in Table V.

Discussion

Yogic exercises improve the psychophysiological functioning of the body as they bring about equilibrium between autonomic responses. It is possible even to condition the higher nervous regions and through these, functions of some of the internal organs of the body which cannot be influenced volitionally[1].

Our study has shown a significant fall in heart rate and a fall in systolic/diastolic BP is also observed after twenty weeks of yogic exercises (Table 1), though not significant. Datey[4] and Lakshmikantan et al[8] have utilised yogic exercises for treatment of hypertension. Datey[4] has suggested that yogic exercises influence the hypothalamus which maintain homoestasis via autonomic nervous system (ANS). It has been recognised that cardiovascular physiology can be influenced by wide variety of behavioural factors such as stress, anxiety and attitudinal dispositions of the individual[6]. This chronic arousal of the hypothalamus with associated increased sympathetic nervous system activity was believed to lead to elevated blood pressure[3]. If this is true, alteration in behavioural factors which are associated with decreased sympathetic activity is expected to lead to a reduction in blood pressure. Two subjects whose baseline ECG had shown low amplitude of T wave in the lateral precordial leads showed the return of T to normal amplitude. Lakshmikantan et al[8] observed in their report that in the post yoga training period, the exercise induced ST-T changes in the ECG during the pre-training period were absent even though the Tension Time Index (T.T.I) was the same. In our normal subjects, we have found a reduction in BP, heart rate, return of normal amplitude of T wave which could be due to a reduction in overall sympathetic activity. Anand[1] has postulated that yogic exercises can bring about a more balanced equilibrium between autonomic responses. Our tilt table studies to assess orthostatic tolerance, which is dependent upon the autonomic cardiovascular response, have not shown any significant alteration in response of the subjects to

TABLE V

Psychological Tests

	PERCEPTUAL SPEED TEST									FOPT			FFF			WMS								
	Total Responses			Correct Response			Ratio									Forward Digit			Backward Digit			Learning		
	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga	Before Yoga	After 7 weeks of Yoga	After 20 weeks of Yoga
SPD	46	48	—	44	48	—	0.96	1.0	—	11.82	12.05	—	35.20	36.0	—	6	6	—	5	5	—	10.5	10.5	—
MBD	60	59	60	57	58	57	0.95	1.0	0.95	11.39	14.29	9.9	31.10	30.8	32.2	6	7	8	5	5	6	15.0	9.0	10.5
JMW	46	49	63	39	49	57	0.35	1.0	0.91	12.20	15.65	6.6	41.70	40.0	34.3	6	6	6	4	4	4	15.0	15.0	14.5
EMI	52	53	54	48	53	53	0.92	1.0	0.98	14.11	13.48	14.14	29.2	28.8	31.1	7	7	6	5	5	5	9	7.5	7.5
TBB	42	37	38	39	35	37	0.93	0.97	0.97	21.34	34.37	17.18	34.2	33.7	35.7	5	5	5	4	4	3	13.5	15	15
YN	47	40	42	41	37	40	0.72	0.93	0.95	28.57	24.71	16.6	30.1	31.2	31.5	6	6	6	4	4	3	11	10.5	13.5
Mean	48.8	47.7	51.4	44.7	47.0	48.8	0.89	0.98	0.95	16.80	19.1	12.88	33.6	33.4	33.0	6	6.2	6.2	4.5	4.3	4.2	12.3	11.3	12.4
Significance		NS	NS		NS	NS		P<0.05	NS		NS	NS		NS	NS		NS	NS		NS	NS		NS	NS

70° HUT (fig.2). It is observed that resting B. P. and heart rate of the subjects prior to tilting did not show as much reduction as compared to early morning heart rate and blood pressure. It is possible that at this stage of yoga training, the changes observed are not yet fully established and possibly with further training, the decreased sympathetic activity resulting from the daily elicitation of the response, may also carry over to the non-relaxation period during the day and result in decreased blood pressure at all times.

Udapa[9] has observed correction of body weight. In our study four out of six subjects have shown reduction in body weight (Table I). This could also be attributable to a certain degree to isometric muscular exercises.

Bhatnagar et al[2] found a reduced increase in the mean body temperature and a reduction in sweat loss in their subjects who had undergone yoga training. They attribute this to a better adjustment of the thermoregulatory mechanisms. We found that even 20 weeks of yoga training reduces, though not significantly, the increase in MBT & HR during direct whole body heating in a hot cockpit. The change in sweat loss in our subjects was minimal (Table III). Even though the method of increasing the body temperature in our experiments was different to that of Bhatnagar who used exercise, our findings also suggest that the thermoregulatory mechanisms may be less strained after yoga training.

Muscular exercise is known to induce cardiovascular changes with reduced HR. It could be suggested that cardiovascular changes seen by us have also been contributed to by muscular effort during yoga. However, the fact that the thermoregulatory mechanism also seems to be affected supports the theory of an overall conditioning of the higher autonomic function influencing areas.

Respiratory function (lung chestwall mechanics) is available at this time only in 4 subjects (Table IV). No comments are being offered on this aspect at present. However, increased VO2 as reported by Bhatnagar et al[2] occurs in the absence of changes in lung chestwall mechanics. It is possible that yoga exercises such as Pranayama may improve even the mechanics of lung function with time.

Udapa et al[10] have reported in their study, increased performance quotient. In our study, performance on perceptual speed test and flight oriented psychomotor test showed (in absolute terms) improvement, though not statistically significant (Table V).

Alpha state is one in which the brain is in awake and yet relaxed and peaceful state[3], characterised by alpha waves. The increase in alpha index observed in the present study may represent an enhanced and yet restful awake state following yogic exercises.

The yoga exercises help the individuals to condition their brain in such a way that the quick restoration of alpha state takes place following any departure from such restful awake periods. The relaxation attendent to the alpha state could have had its beneficial effects in alleviating the normal daily stresses. This is evident, to some extent from the enhanced sense of well being reported by the subjects. These factors, the increased alpha index and the concomittant sense of well being could have contributed to the increased performance efficiency after yoga.

Although the operation of the mechanism that results in changes cannot be fully explained within the scope of this study, it is possible that the hypothalamus plays a major role by virtue of its influence over the ANS and by being an integral part of the limbic system through which impulses are transferred to and from the cortex.

Conclusion

The study suggests that yogic exercises influence the psychophysiological functions in a beneficial way. The findings of the study indicates that involvement of higher nervous regions possibly at the hypothalamolimbic regions in bringing out the above changes. However further studies on a larger sample with more tests for longer periods will throw more light on these aspects.

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