Effects of yogic exercise training on physical and psychophysiological functions

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Body flexibility, resting heart rate and blood pressure, physical fitness index by Harvard step test, state and trait anxiety, and performance on digit symbol substitution test were measured before and after 6 weeks of supervised training in 2 groups of male healthy volunteers taken from ab initio medical assistant trainees. The yoga group (n = 60) performed 1 h yogic exercise schedule 5 days a week and the other group (n = 35) played volley-ball during the same period. The pre-training scores of Harvard step test indicated a physically active sample population. Pre- and post-training assessments indicated significant reduction in resting heart rate and blood pressure, significant improvements in trunk flexion ability and performance in digit symbol substitution score in the yoga group. The volley-ball group showed significant improvement in all 4 measures of body flexibility. The Harvard step test score of physical fitness remained unchanged in both the groups. The observed altered autonomic balance towards parasympathetic dominance in the yoga group is considered useful in relation to tolerance to certain stresses of military significance.

Keywords: Yoga; Psychophysiological effects

Yoga is an ancient Indian practice known to help in developing physical and mental health. Longitudinal studies on yogic practice carried out for periods of 3 months to 1 year had indicated measurable beneficial effects on certain psychological and biochemical functions [1–3], general physical efficiency [3, 4] and body flexibility [5, 6].

The present study was undertaken to evaluate the effects of a short-term training schedule (6 weeks) of yogic practice in bringing about possible measurable changes in physical, physiological and psychological functions in a group of young volunteers taken from *ab initio* medical assistant trainees in the Indian Air Force. Parallel longitudinal studies of the same functions were made in another group of volunteers, taken from the same population, performing normal routine of organized games, viz. volley-ball during the period when the first group of subjects were engaged in yogic practice. Analysis of the pre- and post-training changes in the psychophysiological measurements in the two groups of volunteers allowed comparison between the effects of yogic practice and conventional physical exercise training.

Material and methods

Subjects. Ninety-five normal healthy medical assistant trainees in the age group of 17–21 years formed the subjects of this study. Sixty of them volunteered to take part in the yogic practice in lieu of normally scheduled organized games in the evening and formed the yoga group. The other 35 volunteers continued with the normally scheduled organized game practice, viz. volley-ball during the same period. The age and physical characteristics of the subjects in the two groups are presented in Table 1.

Exercise programme. Both the groups had their practice schedule in the evening hours between 1700 and 1800 h, 5 days a week. The yogic practice schedule consisting of asanas and pranayama was administered and supervised by trained yoga instructors for a period of 6 weeks.

Table 1. Physical characteristics of the subjects (mean ± SD)

Groups	Age (yr)	Height (cm)	Body weight (kg)
Yoga group (n = 60)	19.0 ± 0.74	168.6 ± 4.1	57.0 ± 4.5
Volley-ball group (n = 35)	19.3 ± 0.79	170.3 ± 5.3	56.9 ± 5.0

The normal routine of volley-ball game practice was under the supervision of a PT instructor. The details of the yogic practice programme are listed in Appendix 1.

Measurements. Physical function in terms of body flexibility parameters – stand and reach, sit and reach, trunk extension and shoulder lift – were assessed following the procedure described by Hockey [7]. Physiological measurements included resting supine heart rate and blood pressure and physical fitness index (PFI) by Harvard step test [8] using 18" step height. Psychological function assessment was made by the measurement of state and trait anxiety scores (State and Trait Anxiety Inventory, Consulting Psychologists Press, California, USA) and the performance on speed of coding by digit symbol substitution test (Wechsler Adult Intelligence Scale, Psychological Corporation, New York, USA).

All the above measurements were made twice, once within 2 days prior to the commencement of yoga practice and, on the second occasion, within 2 days of completion of 6 weeks of yoga practice programme.

The pre- and post-training values of the test measures were compared separately in the two groups by means of paired t test.

Results

Table 2 presents body flexibility measures for the yoga and volley-ball groups before and after the training. The yoga group showed significant improvements in stand and reach and in sit and reach values with no changes seen in trunk extension and shoulder lift measures. The volley-ball group, on the other hand, showed significant improvements in all four body flexibility measures.

Table 3 presents the pre- and post-training values of resting heart rate and blood pressure and PFI scores on Harvard step test in the two groups of subjects. The yoga group showed a significant reduction in resting supine values of heart rate ($p < 0.001$), systolic ($p < 0.001$) and diastolic blood pressure ($p < 0.05$). the volley-ball group showed a significant reduction in systolic blood pressure ($p < 0.001$) with no changes seen in heart rate and diastolic blood pressure.

The pre-training mean values of PFI for the yoga and the volley-ball groups were 82.7 and 85.3, respectively, with no significant changes noted in the post-training values.

Table 4 presents the pre- and post-training values of the psychological test measures for the two groups. No significant changes were noted in the anxiety scores with training in either groups. Performance on the speed of coding was found to be significantly improved ($p < 0.001$) in the yoga group only.

Discussion

A few longitudinal studies on the effects of yogic practice had reported improvements in body flexibility [5, 6], general physical and muscular efficiency [3, 4] and a shift in the autonomic equilibrium towards a relative parasympatho-dominance [2, 3]. Many of the above studies asserted on their findings of beneficial effects of yogic practice over those accrued through conventional physical exercise programmes [3–6].

In body flexibility functions, the present study noted that yogic practice, as effected by the protocol administered in the present study, produced significant improvements in trunk flexibility that is reflected in the changes in stand and reach and sit and reach measures. In respect of trunk extension and shoulder flexion (lift) measurements, however, the yoga group did not show any significant changes after

Table 2. Body flexibility measurements before and after training (mean ± SD)

Measurements	Yoga group		Volley-ball group	
	Pre	Post	Pre	Post
Stand and reach (cm)	12.1 ± 7.0	14.7*** ± 6.8	11.2 ± 7.7	14.7*** ± 6.1
Sit and reach (cm)	14.3 ± 6.5	15.8*** ± 7.1	14.8 ± 6.6	16.7** ± 5.7
Trunk extension (cm)	29.1 ± 8.6	28.0 ± 9.7	30.1 ± 8.8	32.4* ± 7.7
Shoulder lift (cm)	40.8 ± 13.5	41.9 ± 13.0	34.7 ± 10.8	40.8*** ± 12.5

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 3. Resting heart rate, blood pressure and physical fitness index before and after training (mean ± SD)

Measurements	Yoga group		Volley-ball group	
	Pre	Post	Pre	Post
Heart rate (bpm)	73.6 ± 7.3	68.7** ± 7.1	76.6 ± 10.9	74.0 ± 9.7
Systolic BP (mmHg)	122.4 ± 10.5	117.4** ± 8.8	126.1 ± 8.6	119.9** ± 8.4
Diastolic BP (mmHg)	72.1 ± 6.4	70.1* ± 7.3	72.1 ± 6.1	70.7 ± 7.2
PFI score	82.7 ± 6.8	82.0 ± 9.9	85.3 ± 9.2	83.4 ± 9.1

*$p < 0.05$; **$p < 0.001$

Table 4. State and trait anxiety score and speed of coding on digit symbol substitution test before and after training (mean ± SD)

Measurements	Yoga group		Volley-ball group	
	Pre	Post	Pre	Post
STAI test				
State anxiety score	39.0 ± 7.6	40.1 ± 7.1	39.5 ± 6.7	41.5 ± 8.9
Trait anxiety score	38.1 ± 7.6	40.2 ± 6.4	42.1 ± 7.6	42.3 ± 8.1
Digit symbol substitution test				
Speed of coding	34.9 ± 6.7	38.9* ± 7.2	39.0 ± 9.8	40.1 ± 10.8

*$p < 0.001$

6 weeks of training. The volley-ball group, on the other hand, showed an all-round improvement in the body flexibility measures.

Moorthy [5] observed that yogic exercises had greater effects compared to conventional exercises in improving trunk flexibility in young children. Ray *et al.* [6] observed no improvement in trunk flexion and extension measures either by yogic or nonyogic exercises in an elderly group of subjects (40–48 yr) but noted significant improvement in shoulder flexion with yogic exercises in their subjects.

The differences in these observations are likely to be attributed to age groups, selection of asanas in the programme and the type of physical exercises involved in the games/ conventional exercise used for the comparative studies. The present sample population comprised adolescents and young adults with a large scope of improvement in body flexibility measures by suitable exercise programmes. The observed all-round improvements in the body flexibility measures in the volley-ball group compliments the game in bringing about these effects. Yogic exercises, on the other hand, was specifically beneficial in effecting trunk flexion measures for the age group participating in this study.

Significant reductions noted in the resting supine heart rate and blood pressure in the yoga group of the present study corroborates the earlier findings of Joseph *et al.* [2] and Selvamurthy *et al.* [3]. In comparison, the volley-ball group had a significant reduction in systolic blood pressure with no significant changes seen in pre- and post-training heart rate and diastolic blood pressure. The results of the present study reiterate the hypothesis of a shift in the autonomic equilibrium towards a relative parasympatho-dominance through yogic practice [2].

When assessed for the physical fitness level by Harvard step test, the initial mean scores of PFI in both yoga group (83.7) and volley-ball group (85.3) were indicative of a general good level of cardiovascular fitness in these volunteers as is expected of an active trainee population in the military. At the end of 6 weeks, however, neither of the two groups of subjects showed any significant changes in their PFI scores. It appears that the intensity of the cardiovascular conditioning programme in the trainees reached a relative plateau by the time the present study was initiated. While no improvement of PFI was noticed through the practice of 6 weeks of yoga, subjects in this group could maintain their initial mean level of PFI in a manner comparable to that of the other group engaged in an otherwise normal workout of volley-ball games.

State and Trait Anxiety Inventory questionnaire was administered primarily with the idea of revealing changes, if any, in the state anxiety levels in the subject groups following yogic practice as compared to the conventional exercise group. Anxiety scores, both state and trait, did not show any significant changes between pre- and post-training values in either group.

Digit symbol substitution test is a one-minute test measuring the speed of coding, a higher score implying better performance in the speed of visual perception, in learning and in motor functions of reproducing the symbols. The mean score of speed of coding was found significantly improved in the post-training measurements in the yoga group ($p < 0.001$). It is, however, worth noting that the initial mean score of speed of coding was significantly lower ($p < 0.05$) in the yoga group as compared to the other group and it is certainly hard to explain this difference between the fractions of an otherwise homogeneous group. Nevertheless, the observed improvement in the score after yogic practice merits special attention since this implies an improvement in the performance efficiency on a task involving perception, learning and speed of motor response.

Conclusion

Considering the overall effects of yogic practice as administered in this study, it may be concluded that a daily exercise of about 1 h duration of yogic practice for a period of 6 weeks is capable of producing measurable changes in the desirable direction in several psychophysiological functions.

In view of these findings it is recommended that yogic practice should be considered as an effective method of training, meriting its inclusion in organized positive-health programmes. Changes in autonomic balance towards a relaive parasympatho-dominance as attained through yogic practice may be useful in effecting greater olerance to a few stresses of military significance.

In terms of physical functions of body flexibility changes, the volley-ball group showed better results over the yoga group. An appropriate integration of yogic practice and conventional exercise/games is likely to produce the best results.

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Appendix 1. Details of yogic practice schedule

Order of yogic practices	Duration (min)
1. **Sithilikarana exercises**	
(a) Dhavti	4
(b) Stretch-up exercises	3
2. **Suryanamaskar**	5
3. **Asanas in standing posture**	
(a) Ardhakati chakrasana	1
(b) Parsva konasana	2
(c) Ardha chakrasana	1
(d) Pada hastasana	1
(e) Parivarta trikonasana	2
4. **Uddiyana Bandha**	1
5. **Asanas in sitting posture**	
(a) Vazrasana	1
(b) Ustrasana	1
(c) Pascimathanasana	1
(d) Ardha matsyendrasana	1
(e) Padmasana	1
(f) Yoga mudra	1
6. **Asanas in supine posture**	
(a) Viparitakarani	2
(b) Sarvangasana	2
(c) Mateyasana	2
(d) Halasana	1
(e) Chakrasana	1
7. **Asanas in prone posture**	
(a) Bhujangasana	1
(b) Salabhasana	1
(c) Dhanurasana	1
8. **Savasana**	2
9. **Kapalbhati**	1
10. **Savasana**	10
11. **Nadisuddhi Pranayama**	4
Total	55