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# EFFECT OF YOGA TRAINING ON REACTION TIME, RESPIRATORY ENDURANCE AND MUSCLE STRENGTH

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**Abstract:** There is evidence that the practice of yoga improves physical and mental performance. The present investigation was undertaken to study the effect of yoga training on visual and auditory reaction times (RTs), maximum expiratory pressure (MEP), maximum inspiratory pressure (MIP), 40 mmHg test, breath holding time after expiration (BHTexp), breath holding time after inspiration (BHTinsp), and hand grip strength (HGS). Twenty seven student volunteers were given yoga training for 12 weeks. There was a significant ($P< 0.001$) decrease in visual RT (from $270.0 \pm 6.20$ (SE) to $224.81 \pm 5.76$ ms) as well as auditory RT (from $194.18 \pm 6.00$ to $157.33 \pm 4.85$ ms). MEP increased from $92.61 \pm 9.04$ to $126.46 \pm 10.75$ mmHg, while MIP increased from $72.23 \pm 6.45$ to $90.92 \pm 6.03$ mmHg, both these changes being statistically significant ($P< 0.05$). 40 mmHg test and HGS increased significantly ($P<0.001$) from $36.57 \pm 2.04$ to $53.36 \pm 3.95$ s and $13.78 \pm 0.58$ to $16.67 \pm 0.49$ kg respectively. BHTexp increased from $32.15 \pm 1.41$ to $44.53 \pm 3.78$s ($P< 0.01$) and BHTinsp increased from $63.69 \pm 5.38$ to $89.07 \pm 9.61$ s ($P< 0.05$). Our results show that yoga practice for 12 weeks results in significant reduction in visual and auditory RTs and significant increase in respiratory pressures, breath holding times and HGS.

**Key words:** yoga practice, hand grip strength, breath holding time, respiratory pressure

## INTRODUCTION

Yogic techniques, which aim at physical and mental self culture, have convincing scientific bases and produce consistent physiological changes (1,2,3). It has been reported that yogis are capable of remarkable feats of endurance (4,5) and controlling their autonomic functions (6,7). There is evidence that the practice of yoga improves cardiorespiratory efficiency (1,8) and performance quotient (1). In an earlier work from our laboratories, we have demonstrated that subjects trained in yoga can achieve a state of deep psychosomatic relaxation associated with a significant reduction in oxygen consumption (9). These studies indicate that yoga has practical application for improving human performance.

In a recent study, Malathi and Parulkar (10) have reported that yoga training course of six weeks duration produces a significant decrease in visual and auditory reaction times (RTs). Being an interesting and novel observation, this needs confirmation. Further, Nayar et al (11) have observed a significant increase in breath holding time after yoga training whereas Gopal et al (8) have reported a slightly lower breath holding time in yoga trained subjects.

In view of this, we planned to undertake a systematic study on the effects of yoga training on various physiological parameters of healthy young volunteers. In the present paper we report on the effects of yoga training on visual and auditory RTs, maximum expiratory pressure (MEP), maximum inspiratory pressure (MIP), 40 mmHg test, breath holding time after expiration (BHTexp), breath holding time after inspiration (BHTinsp), and hand grip strength (HGS).

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## METHODS

The present study was conducted on 27 male medical student volunteers residing in the college hostel. All the subjects were healthy. However, none was involved in any athletic training program. Their history and clinical examination did not reveal any abnormality. The subjects were non-smokers, took no drugs and had a uniform pattern of diet and activity. Their age was 18-21 yr, weight 50-69 kg and height 161-179 cm. The subjects were briefed about the study protocol and informed consent was obtained from them. The following parameters were measured:

1. RT for light, 2. RT for sound, 3. MEP, 4. MIP, 5. 40 mmHg test, 6. BHTexp, 7. BHTinsp, 8. HGS

Two days before the actual study, the subjects reported to our laboratory and were familiarized with the experimental procedures. For each test, practice trials were administered until we were satisfied that the subjects understood and performed the task as required of them. RTs and HGS were measured by the right hand which was the dominant hand in all the subjects.

Control measurements were taken ~ 2 h after a light breakfast and 30 min rest and instructions in the laboratory. All the tests were performed while the subject was sitting comfortably in a chair. RTs for light and sound were measured on a fast moving paper as described in our previous study (12). The visual as well as auditory signals were given from front. We recorded > 10 RT measurements and mean of 3 similar observations was taken as an individual value for statistical analysis.

MEP was determined by asking the subjects to blow against a mercury column after taking in a full breath (to TLC) and to maintain the column at the maximum level for ~ 2 s. MIP was determined by asking the subjects to perform maximal inspiratory effort against the mercury column after breathing out fully (to RV). The maximum inspiratory pressure that could be maintained for ~ 2 s was noted.

40 mmHg test was conducted by asking the subjects to take in a full breath and blow against the mercury column to the pressure of 40 mm, maintaining it as long as possible. The time (in seconds) for which the subject could maintain the mercury level at 40 mmHg was noted. The lips were secured tightly around the mouthpiece with the help of fingers to ensure that there was no leak. Care was taken to see that the subjects did not use oral muscles or tongue to develop pressure or to block the tubing. A mouth piece made of glass helped us to observe that the subjects performed the maneuver properly.

BHTexp was determined by noting the maximum time (in seconds) for which the subject could hold his breath after breathing out fully. Similarly, BHTinsp was determined after taking in a full breath. It was ensured that there was no hyperventilation prior to breath holding. Care was taken to see that the subjects did not make any chest or abdominal movement during the breath holding.

HGS was measured with the dominant hand gripping a hand dynamometer (INCO, India) and the arm outstretched in front and parallel to the ground. For determining respiratory pressures, 40 mmHg test, breath holding times and HGS, measurements were repeated with 2 min rest periods between each recording and the best of 3 similar values was considered for analysis.

After the control measurements were determined, the subjects were given yoga training. The sequence of the techniques practised and their durations are given in Table I. Detailed description of these techniques is

TABLE I: Sequence and duration of yoga techniques practised by our subjects.

| | *Yoga technique* | *Duration (min)* |
|---|---|---|
| 1. | Mukh bhastrika | 0.5 |
| 2. | Bandh trayam | 0.5 |
| 3. | Nauli | 0.5 |
| 4. | Talasan | 0.5 |
| 5. | Trikonasan | 1.0 |
| 6. | Ardh matsyendrasan | 1.0 |
| 7. | Supt vajrasan | 1.0 |
| 8. | Ushtrasan | 1.0 |
| 9. | Paschimottanasan | 1.0 |
| 10. | Shirshuttanasan | 1.0 |
| 11. | Pavanmuktasan | 1.0 |
| 12. | Sarvangasan | 1.0 |
| 13. | Halasan | 1.0 |
| 14. | Matsyasan | 1.0 |
| 15. | Navasan (supine) | 1.0 |
| 16. | Navakasan (prone) | 1.0 |
| 17. | Bakasan | 1.0 |
| 18. | Shavasan | 15.0 |
| Total duration | | 30.0 |

given in most of the standard texts on yoga (13,14). Practice sessions were held for 30 min early in the mornings, Monday through Saturday, for a duration of 12 weeks under the direct supervision of one of the authors (M). All the measurements described above were repeated after the yoga training. As the period of yoga training was only 12 weeks and the subjects formed their own control, a separate control group was not incorporated. The observations and the significance of their changes were not discussed with the subjects at any time during the study.

The data was subjected to statistical analysis using Student's "*t*" test. P values of less than 0.05 were accepted as indicating a significant difference between the compared values.

## RESULTS

The results are expressed as mean ± SE (n=27) and shown in Fig. 1 and 2. Before yoga training, the RT for light was 270.0±6.20 ms and the RT for sound was 194.18±6.00 ms. After yoga training, the RT for light decreased to 224.81±5.76 ms while the RT for sound decreased to 157.33±4.85 ms, the decrease in both these values being statistically significant (P < 0.001). Control values for MEP and MIP were 92.61± 9.04

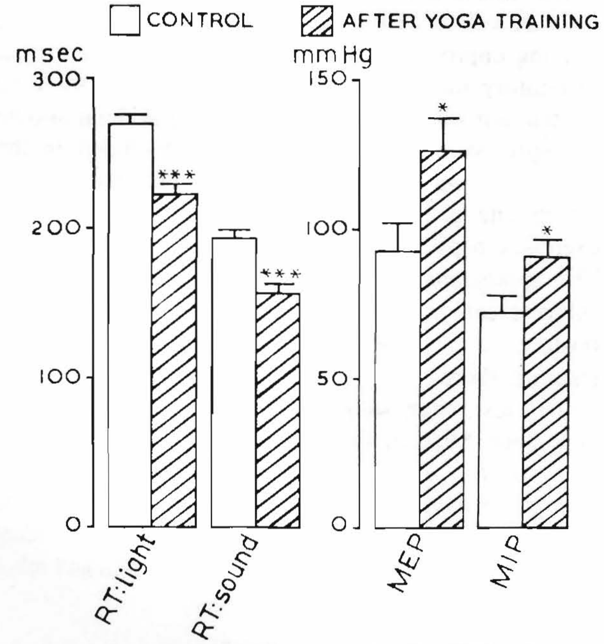


Fig. 1 : Effect of yoga training on reaction time (RT) to light and sound, maximum expiratory pressure (MEP) and maximum inspiratory pressure (MIP). Values are means ±SE. *P<0.05, *** P<0.001.

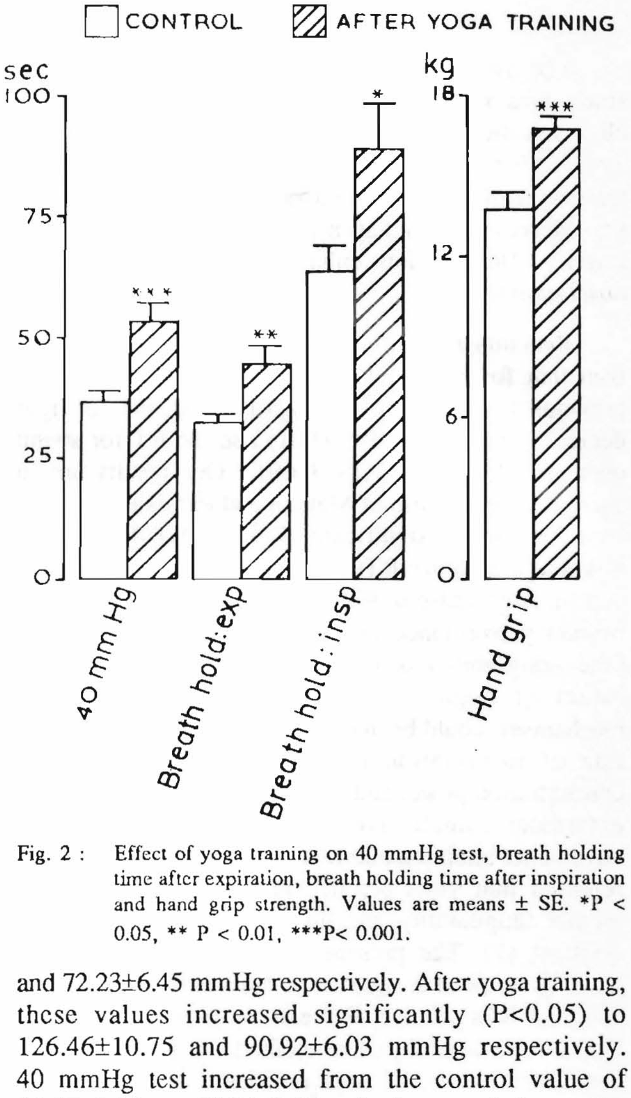


Fig. 2 : Effect of yoga training on 40 mmHg test, breath holding time after expiration, breath holding time after inspiration and hand grip strength. Values are means ± SE. *P < 0.05, ** P < 0.01, ***P< 0.001.

and 72.23±6.45 mmHg respectively. After yoga training, these values increased significantly (P<0.05) to 126.46±10.75 and 90.92±6.03 mmHg respectively. 40 mmHg test increased from the control value of 36.57±2.04 s to 53.36±3.95 s, the increase being statistically significant (P<0.001). BHTexp was 32.15± 1.41 s before the yoga training and 44.53±3.78 s after the yoga training, the increase being statistically significant (P< 0.01). BHTinsp also showed a significant increase (P<0.05) from the control value of 63.69± 5.38 s to the post training value of 89.07±9.61 s.

Yoga training increased the HGS to 16.67±0.49 kg from the control value of 13.78±0.58 kg, the increase being statistically significant (P < 0.001). All the subjects reported that after yoga training they felt fresh and more alert and could concentrate on their studies better.

## DISCUSSION

The yoga training regime used in the present study was of sufficient intensity and duration to elicit significant changes in all the parameters studied. The number of subjects used was 27 and all the volunteers were of the same sex (M) and similar age (18-21 yr). Moreover, they had a similar pattern of diet and activity. These points enhance the reliability of our observations.

*Reaction time:* Control RT for sound was shorter than that for light and this is in agreement with our previous study (12). After yoga training, RT for light decreased by ~ 17% (P< 0.001) and the RT for sound decreased by ~ 19% (P< 0.001). Our results are in agreement with those of Malathi and Parulkar (10) who have reported a significant (P < 0.001) decrease in visual and auditory RTs after six weeks yoga training course. A decrease in RT indicates an improved sensorimotor performance and could be due to an enhanced processing ability of the central nervous system. The effect of yoga training on the central nervous mechanisms could be due to i) greater arousal and faster rate of information processing and ii) improved concentration power and ability to ignore and/or inhibit extraneous stimuli. Yoga practitioners are known to have better attention and less distractibility. It has been reported that yoga practice results in a decrease in mental fatiguability and an increase in performance quotient (1). The present study confirms that yoga training leads to a significant reduction in visual and auditory RTs. Hence, RT can be used as a simple, quantitative and objective method for monitoring the beneficial effects of yoga practice.

*Respiratory pressures :* Respiratory muscles are vital and evaluation of their performance is important (15). Maximum respiratory pressures are specific indices of respiratory muscle strength and their values can be altered in patients even when there is little abnormality in other commonly used pulmonary function tests (16). We measured MEP after the subjects took in a full breath while MIP was measured after the subjects breathed out fully, since the highest MEP is obtained at lung volumes of more than 70% of total lung capacity and the highest MIP is obtained at lung volumes of less than 50% of total lung capacity (17). Chen and Kuo (15) also have reported a similar dependence of the respiratory muscle strength on lung volume. In the present study, the control values of MEP and MIP were 92.61 ± 9.04 and 72.23 ± 6.45 mmHg respectively. Black and Hyatt (16) reported higher values for MEP and MIP in males than the present study. However, our values are closer to those of Chen and Kuo (15) who have reported that in young men, the mean inspiratory muscle strength at residual volume is 90.73 mmHg and the mean expiratory muscle strength at total lung capacity is 103.82 mmHg. The lower control respiratory pressures observed in the present study could be due to the fact that our subjects were sedentary and were not involved in any sports or physical fitness activities. Krishnamurthy et al (18) also have reported lower MIP (95.0 ± 18.64 mmHg) in Indian male student volunteers. After yoga training, MEP increased by ~ 37% and MIP increased by ~ 26%, both these changes being statistically significant (P< 0.05). Our results do not agree with those of Gopal et al (8) who have reported a lower MEP in yoga trained subjects as compared to untrained subjects. Inspiratory muscle endurane has been reported to be greater in physically active men than sedentary men (15). The increase in MEP as well as MIP in our subjects suggests that yoga training improves the strength of expiratory as well as inspiratory muscles. Yoga postures involve isometric contraction which is known to increase skeletal muscle strength. Mukh bhastrika (Table I) included in the present training program is a bellows type breathing in which one breaths forcefully and rapidly and thus exercises inspiratory as well as expiratory muscles (13). The appreciable increases in MEP and MIP in our subjects can be attributed to a combination of yoga postures and the bellows type breathing. After yoga training there was ~46% increase (P<0.001) in 40 mmHg test, suggesting an improved cardiorespiratory endurance. Measurement of respiratory pressures which is a specific test for measuring respiratory muscle strength, is easy to perform, reproducible and produces no complications (15,16). Hence, these tests are ideal for objective evaluation of the effects of yoga and other physical training programs.

*Breath holding time :* Yoga training produced ~ 39% increase in BHTexp and ~ 40% increase in

BHTinsp. Gopal et al (8) have reported a slightly lower BHT in yoga trained subjects as compared to untrained controls (54 vs 57 s). However, Nayar et al (11) have reported a significant increae (from 54 to 106 s) in BHTinsp after yoga training. BHT depends on the initial lung volume, training and will power of the subject. In the present study, BHTinsp was longer than BHTexp. Greater lung volume decreases the frequency and amplitude of involuntary contractions of respiratory muscles thereby lessening the discomfort of breath holding (19). Hence, it is easy to hold breath near total lung capacity than near residual volume. During yoga practice, one consciously and consistently overrides the stimuli to the respiratory centers, thus acquiring some degree of control over the respiration. This, apart from an improved cardiorespiratory endurance, might be responsible for prolongation of BHT in yoga trained subjects. It is also possible that yoga training might alter the responsiveness of medullary and/or systemic arterial chemoreceptors with consequent prolongation of BHT.

*Handgrip strength:* Yoga training produced ~ 21% increase in HGS. This is not in agreement with the observations of Udupa and Singh that in contrast to physical exercises, yogasanas specifically influence vital organs and glands without affecting the muscular functions (1). However, our observation is consistent with those of Ray et al (20) who have reported that yoga exercises produce a significant increase in muscle endurance time and delay in the onset of fatigue. The present study shows that the isometric contraction during yoga postures leads to a significant increase in muscle strength. All our subjects reported that they felt more alert and fresh and could concentrate better on their studies. This is in agreement with the findings of Udupa and Singh (1) that the practice of yoga increases the performance quotient and makes a person psychologically more stable and mentally more competent.

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