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EFFECT OF SHORT TERM 'PRANAYAM' PRACTICE ON BREATHING RATE AND VENTILATORY FUNCTIONS OF LUNG

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Abstract : Thirty three normal male and forty two normal female subjects, of average age of 18.5 years, underwent six weeks course in 'Pranayam' and their ventilatory lung functions were studied before and after this practice. They had improved ventilatory functions in the form of lowered respiratory rate (RR), and increases in the forced vital capacity (FVC), forced expiratory volume at the end of 1st second (FEV_1%), maximum voluntary ventilation (MVV), peak expiratory flow rate (PEFR-lit/sec), and prolongation of breath holding time.

Key words : Pranayam

INTRODUCTION

Yoga is a science practised in India over thousands of years. There are four classical paths described to reach the ultimate goal of yoga. It is claimed that practice of Ashtang yoga, especially 'Pranayam', improves both the physical and spiritual health.

'Pranayam' is a Yogic technique in which breathing is controlled voluntarily. There are various methods of pranayam, mostly characterised by breath holding at the end of maximal inspiration or maximal expiration and slowing of the respiratory rate. Previous studies have been conducted on the effects of certain combined practices of yoga (2, 3, 4).

The present study however was undertaken to ascertain whether pranayan alone has any effect on the ventilatory lung functions, which depend on compliance of lung and thorax, airway resistance and strength of respiratory muscles.

METHODS

33 normal male and 42 normal female medical students, of average age of 18.5 yrs, underwent a six weeks practice in pranayamic breathng and were studied for ventilatory functions before and after the yogic course. The subjects did not undertake any other physical activity such as sports or atheletic training. Each subject acted as his or her own control. No subject had been performing any yoga practice before.

Pranayamic practice each time as indicated below, lasted for 20 minutes and was practised twice a day on week days and once on saturday, for a total period 6 weeks.

(i) First 2 minutes — slow deep maximum inhalation & exhalation each lasting for 5 secs. Thus RR was 6/min.

(ii) Middle 16 minutes— 5 secs - slow, maximum inhalation

17 secs - holding breath with efforts at same lung vol.

8 secs - slow maximum exhalation.

(iii) Last 2 minutes — same as in (i)

Subjects were instructed to breath through their nostrils with eyes closed and concentrate on breathing, while they were sitting straight on chairs. Breathing was monitored with audiotape.

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Study of ventilatory functions was carried out on a computarized pulmonary testing machine ('medspiror' Med System Pvt. Ltd:, Chandigarh). Each subject was given three trials and maximum readings were considered. Breath holding time was measured by stopwatch. Respiratory rate was measured clinically.

Following ventilatory functions were studied.

1) R.R. min - Respiratory rate
2) BHT $\frac{\text{TLC}}{\text{R.V.}}$ Breath holding time at total lung capacity and at Residual volume in seconds.
3) FVC in lit. - Forced vital capacity
4) FEV_1% Forced expiratory vol. at the end of first second in %.
5) MVV - lit/min. Maximum voluntary ventilation
6) PEFR - lit/sec. Peak expiratory flow rate.

Results were calculated by paired 't' test. Comparison of results between males and females was done by unpaired 't' test.

RESULTS AND DISCUSSION

The results are presented in Tables I and II.

TABLE I : Spirographic values : Before and after a course of pranayamic breathing.

Males

Test	Mean Before	After	Mean difference ± SD	t	p
R.R./min n = 28	18.2	17.5	2.07 ± 1.99	5.5	S
BHT TLC	53.4	73.5	22.9 ± 20.8	6.3	S
BHT RV n= 33	37.5	44.5	12.85 ± 9.89	6.7	S
FVC n = 23	3.169	3.20	0.47 ± 0.27	8.04	S
FEV_1% n=23	95.2	94	4.46 ± 4.24	5.5	S
MVV n=33	124.9	137.2	23.7 ± 22.08	6.1	S
PEFR	6.9	7.3	1.55 ± 1.22	7.2	S

$P < 0.001$; S = Significant

TABLE II : Spirographic values : Before and after a course in "Pranayam"

Females

Test	Mean Before	After	Mean difference ± SD $\bar{X}$	t	p
R.R./min n = 40	19.2	19.1	1.875± 1.71	6.9	S
BHT TLC	41.9	54.9	15.7 ± 13.9	7.3	S
BHT RV n= 42	29.7	39.6	17 ± 14.99	5.2	S
FVC n = 39	2.31	2.37	0.31 ± 0.20	9.06	S
FEV_1% n=35	95.58	96.91	3.2 ± 3.04	6.2	S
MVV n=42	85	94	17.1 ± 14.7	7.5	S
PEFR n = 42	3.5 .	5:1	1.24 ± 0.96	18.3	S

$P < 0.001$; S = Significant

TABLE III

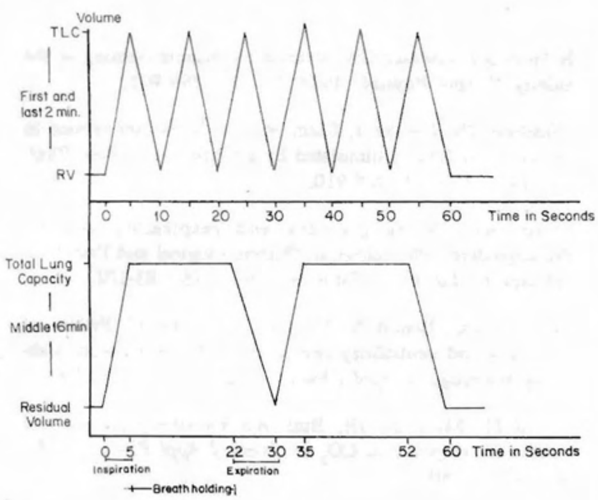
Parameters	Male $\bar{X}_2$ ± SD	Female $\bar{X}_1$ ± SD	t	p
R.R. -	2.07 ± 1.99	1.87 ± 1.71	0.42	N.S.
BHT TLC	22.9 ± 20.8	15.7 ± 13.9	1.7	N.S.
BHT RV	12.85 ± 9.89	17.0 ± 14.99	1.09	N.S.
FVC	0.435 ± 0.287	0.316 ± 0.222	1.98	S.
FEV_1%	5.13 ± 4.36	5.44 ± 4.66	0.25	N.S.
MVV	23.7 ± 22.08	17.1 ± 14.7	1.48	N.S.
PEFR	1.55 ± 1.22	1.24 ± 0.96	1.20	N.S.

N.S. = Non-significant; S = Significant; $P < .05$

Comparison of results between males and females is in Table III. The pattern of breathing is indicated in Fig. 1

I. There was a significant decrease in the rate of respiration, both in males and females. Similar observations have been reported by others (5, 6). Usually breathing is not a conscious event and is regulated automatically by bulbopontine respiratory control mechanisms, which are further modified by supra-pontine mechanisms in the conscious being. The pneumotaxic center is sup-

SHEMATIC REPRESENTATION OF BREATHING DURING 'PRANAYAM'



posed to relay suprapontine messages which promote voluntary inspiration and expiration (7). During daily practice of pranayamic breathing the basic activity of bulbopontine complex is modified in such a way as to slow down its rhythm, by voluntarily prolonging the phase of inspiration and expiration by stretching to their fullest extents, thus making respiratory apparatus to work to maximal extent.

Thus we may hypothesize that by voluntarily practicing prynayamic breathing for few weeks, the bulbopontine complex is adjusted to a new pattern of breathing which is slower than its basal rhythm.

II. There were significant increases in FVC, MVV and PEFR, both in males and females. Similar observations have been recorded by others (3, 6). The FEV_1%, which was increased significantly in females but decreased in males, needs to be studied further. Most of these effects could be explained on the following basis.

(a) There occurs strengthening of respiratory musculature incidental to regular practice of pranayamic breathing during which the lungs and chest inflate and deflate to fullest possible extent and muscles are made to work to maximal extent. Similar ventilatory training even in elderly subjects (age 60 to 75 yrs) has shown to improve lung volumes and capacities (8).

(b) Secondly lung inflation near to total lung capacity is a major physiological stimulus for the release of lung surfactant (9) and prostaglandins into alveolar spaces (10), which increase lung compliance and decrease bronchiolar smooth muscle tone, respectively.

III. There is significant increase in BHT at TLC, RV both in males and females which may be due to

(a) Decreased responsiveness to CO_2 either of the respiratory centre or of some chemoreceptors (unconfirmed) as reported in subjects practising pranayamic breathing (11). Deep sea divers and scubadivers, who practice breath holding maneuvers, also show decreased responsiveness to CO_2 (12, 13) manoeuvres.

(b) An alternate explanation involves that practice of yoga, including pranayam, produces a wakeful hypometabolic state (14) of the body characterised by decreased CO_2 production and decreased O_2 consumption, thus allowing breath holding for a longer time.

(c) In addition, increased development of respiratory musculature, incidental to regular practice of pranayamic breathing, causes increased muscle endurance and delays the onset of their fatigue, thus allowing the breath holding for longer time.

Thus the present study, though incomplete, suggests that regular practice of pranayamic breathing improves ventilatory functions of the lungs as shown by increase in FVC, MVV, PEFR; increase in the tolerance to CO_2 as shown by prolongation of BHT; and decreases the rate of respiration.

Comparison of results (Table III) between males and females show that both responded similarly to pranayamic breathing.

REFERENCES

1. Swami Vivekanand Kendra : Yoga research foundation - New perspectives in stress management - 1989.

2. Bhole MV, Karmbelkar PV. Effects of Yoga training on vital capacity and breath holding time. *Yoga Mimansa* 1971 - 1972; 14 : 19.

3. Gopal KS, Bhatnagar OP, Subramanian N, Nishith SD. Effects of yogasanas and pranayam on blood pressure, pulse rate and some respiratory function tests. *Indian J Physiol Pharmacol* 1973; 17: 273-276.

4. Makwana K, Khirwadkar B, Gupta HC. Effect of short term yoga, practice on ventilatory functions of lung. *Indian J Physiol Pharmacol* 1988 ; 32 (3) 202-208.

5. Bhole MV. Treatment of bronchial asthama. *Yoga Mimansa* 1967; 9 (3) : 33.

6. Udupa KN, Singh RM, Shettiwar RH, Singh MB. Physiological changes following some yogic and non-yogic exercises. *Ind J Med Res* 1975; 10 (2) : 91-96.

7. Samson Wright's Applied Physiology. 1982, 13th ed 167-169.

8. Belman MJ, Gaesser GA. Ventilatory muscle training in the elderly. *J Appl Physiol* 1988; 64 (3) : 899-905.

9. Hildebran JN, Georke J, Clements JA. Surfactant release in exercised rat lung is stimulated by air inflation. *J. Appl Physiol* 1981; Vol. 51, 905-910.

10. Smith AP. Prosta glandins and respiratory system-Prostagandins : Physiological, Pharmacological and Pathological aspects. *Edited by SMM. Karim* 1976 ; 83-102.

11. Stanescu DC, Benoit N, Veriter C, Marchal C. Pattern of breathing and ventilatory response to CO_2 in subjects practising Hathyoga. *J Appl Physiol* 1981; 51 : 1625-1629.

12. Florio JT, Morrison JB, Butt WS Breathing pattern and ventilatory response to CO_2 in divers. *J Appl Physiol* 1979; 46 : 1076-1080.

13. Froeb HF. Ventilatory response of scuba divers to CO_2 inhalation. *J Appl Physiol* 1960; 16 : 8-10.

14. Wallace RK, Benson H, Wilson AF. A wakeful hypometabolic physiologic state of the body. *Am J Physiol* 1971· 221: 795-799.