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EFFECT OF TRANSCENDENTAL MEDITATION (TM) AND STRESS MANAGEMENT PROGRAM ON RESPIRATORY RATE AND BREATH HOLDING TIME – A COMPARATIVE STUDY.

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Abstract- For the present study 150 volunteers (75 males and 75 females) were selected. Two groups were made each containing 75 volunteers. Group I volunteers (37 males and 38 females) were trained for doing TM. After the training period they practiced TM every day 20 minutes for 6 weeks. Respiratory rate and Breath holding time (BHT) were recorded before and after the practicing session in each volunteer and results were statistically analyzed.
Group - II volunteers (38 males and 37 females) were subjected to stress management programme. In this session they practiced various breathing exercises, some asana and relaxation technique for 20 minutes for 6 weeks. Respiratory rate and Breath holding time were recorded before and after the practicing session in each volunteer and results were statistically analyzed.
Comparison of results of TM and stress management programme was done by statistical analysis. Both the sessions were equally effective. There was significant reduction in respiratory rate and increase in breath holding time in both the groups. However there was significant increase in breath holding time in Group II as compared to Group I indicating stress management programme was more effective in increasing the breath holding time.
Key words- Transcendental Meditation (TM), respiratory rate, Stress management programme, Breath holding time (BHT).

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Introduction

For obtaining optimum physical and mental health yoga can help medical science. Medical science mainly deals with the 'outer world' which includes body whereas yoga deals with the 'inner world' or mind[1]. Linkages between body and mind are well appreciated and therefore it is quite likely that yoga and medical science together can achieve the goal of optimum functioning of human body and mind. Yogic practices mainly change body functions through autonomic nervous system [2-5] as autonomic nervous system links brain and body.
There are different yogic practices such as meditation, asanas, mudras, various breathing exercises. In the present study effect of TM and stress management program including some breathing exercises, asanas, and mudras is studied.
In one group effect of 6 weeks of TM practice is studied on respiratory rate and breath holding time. In the other group effect of stress management program on respiratory rate and breath holding time is studied. Goal of the present study was to compare the effects of TM and stress management and to find out which is better.

Methods and materials

For the present study one hundred and fifty volunteers were selected. Seventy five volunteers were males and seventy five volunteers were females. Following criteria were used for selecting the volunteers.
Age between 20 to 40 years
No history of heart attack, hypertension, diabetes, or any other

chronic illness that required regular pharmacological treatment.
No history of major psychiatry disorders, current alcohol abuse/ dependency disorders.
Each volunteer was explained the whole programme. Interested and co-operative volunteers were selected. Written consent was obtained from volunteers. The volunteers were asked to discontinue if they felt giddy. An approval of institutional medical ethics committee was obtained before commencing the study. Name, age, sex, height and weight of each volunteer were recorded. Following parameters were studied in each volunteer at rest and were noted as controlled readings.

Respiratory rate
One inspiration followed by expiration is considered as one respiratory cycle. Counting of respiratory rate was done with special care because if person becomes conscious of his/her breathing, the respiratory rate changes. To avoid this, attention of the volunteer was distracted by talking with him. Respiratory rate was noted as stated above for three times and average was taken and noted as respiratory rate per minute.

Breath holding time (**Breath holding after full inspiration)**
Volunteer was asked to take inspiration and then hold the breath as long as possible. Breath holding time was noted (in seconds) by using a stopwatch. Volunteer was given practice and then breath holding time was measured three times with rest pauses in between the consecutive tests. Average was noted as breath holding time (in seconds)
Volunteers were divided in two main groups. Group I and Group II each of 75 volunteers. Group I was further subdivided into group I (males) consisting of 37 male volunteers and group I (females) consisting of 38 female volunteers. Group II was further subdivided into group II (males) consisting of 38 male volunteers and group II (females) consisting of 37 female volunteers. Group I underwent session one and Group II underwent session two.
Session one and two were divided into:
1.Training session for 6 weeks
2.Practicing session for 6 weeks

Session one
Training session
In this session volunteers were trained for Transcendental meditation (TM). This is a progressive relaxation technique. Technique was taught by giving individualized personal instructions. Technique of TM was taught as below [6, 7, 8, and 9]
Meditator sits quietly in a comfortable position with his back erect, eyes closed, (lotus position) and takes slow and deep breaths.
Meditator silently repeats a mystical sound (mantra- OM) Repetition of mantra is supposed to be effortless. Meditator neither attempts to concentrate on sound nor attempts to prevent his/her attention from wavering. There is no need to prevent thoughts during TM. The meditator is instructed merely to concentrate on mantra. Gradually meditator learns to maintain awareness of mantra excluding the other thoughts, external influences and desires.

Practicing session
Volunteers in GroupI practiced TM for 20 minutes in the morning everyday for 6 weeks.

Session two
Training session
Volunteers underwent stress management programme [10] training for 6 weeks. In this programme volunteers were explained about what is stress, different kind of stressors, mechanism by which stress acts on the body. Volunteers were taught about importance of holistic health and its role in stress management. Volunteers were also informed about importance of sprouts, fruits and proteins in the diet. Additionally they were taught some breathing exercises, mudras, and asanas as shown in the table.

Stress Management Programme

Steps	Programme	Duration
1	Stress and stressors	2 Hours
2	Stress identification and construction of stressor hierarchy	1 Hour
3	Autonomic responses to stress	1 Hour
4	Effects of stressors on various systems of the body	1Hour
5	Importance of fruits, fluids, proteins in the diet.	10 Minutes
	Training is given for the following [25] 1. Breathing exercises 2. Anulom and vilom type of breathing 3. Mudras • Brahmamudra • Sinhmudra 4. Relaxation • Jaw relaxation • Makarasan • Nasikagra –drushti 5. Asanas • Bhujangasana • Vakrasana	

Practicing session
Volunteers of Group II practiced breathing exercises, mudras, asanas, and relaxation techniques everyday in the morning 20 minutes for 6 weeks.
At the end of practicing sessions respiratory rate and breath holding time were recorded from all the volunteers of Group - I and Group - II. The results obtained were compared with the control readings taken before the sessions.
Student's "t" test was applied for statistical analysis of the results.

Results
1. Effect on respiratory rate
- There was highly significant decrease in respiratory rate, after the sessions in males and females of both the groups. (Table - I)
- Comparison of results in Group I and Group II showed no statistically significant difference between two groups in both males and females. (Table - III). This indicates that both the sessions were equally effective in lowering the respiratory rate
- Comparison of results in males and females of each group showed no statistically significant difference indicating that effect of each session on respiratory rate was almost equal in males and females. (Table - V)

2. Effect on breath holding time
- There was highly significant increase in breath holding time in both the groups in males and females. (Table - II)

- Comparison of results in Group I and Group II of males as well as females showed statistically significant difference in both males and females of Group I and Group II (Table - IV). Breath holding time in Group II as compared to Group I was greater in both males and females. Session - 2 (Stress management) therefore appears to be more effective than Session - 1
- Comparison of results in males and females of each group showed no statistically significant difference (Table - VI) indicating that effect of each session on breath holding time is almost equal in males and females.

Table 1- Comparison of Respiratory Rate per Minute – Before and After the Sessions in Males and Females of both Groups

Groups		No. of Observations	Mean (x)	S.D.	S.E.	t-value	p-value	Significance
Group-I (Males)	Before	37	16.65	1.038	0.243	26.8	<0.0004	Highly Significant
	After	37	10.14	1.052				
Group-I (Females)	Before	38	16.3	1.135	0.236	26.2	<0.0004	Highly Significant
	After	38	10.1	0.881				
Group-II (Males)	Before	38	15.9	1.085	0.233	26.6	<0.0004	Highly Significant
	After	38	9.7	0.938				
Group-II (Females)	Before	37	16.4	1.121	0.238	26.89	<0.0004	Highly Significant
	After	37	10	0.915				

Table 2- Comparison of Breath holding time (sec) – Before and After the Sessions in Males and Females of both Groups

Groups		No. of Observations	Mean (x)	S.D.	S.E.	t- value	p-value	Significance
Group-I (Males)	Before	37	50.84	4.99	1.031	12.66	<0.0004	Highly Significant
	After	37	63.89	3.8				
Group-I (Females)	Before	38	35.34	5.03	1.11	11.12	<0.0004	Highly Significant
	After	38	47.68	4.62				
Group-II (Males)	Before	38	47.39	5.03	1.024	15.09	<0.0004	Highly Significant
	After	38	62.84	3.81				
Group-II (Females)	Before	37	35.49	5.5	1.233	12.1	<0.0004	Highly Significant
	After	37	50.38	5.11				

Table 3- Comparison of Effect of Respiratory Rate per M in Group I and Group II

Groups		No. of Observations	Mean (x)	S.D.	S.E.	t- value	p-value	Significance
Group-I	Males	37	6.5	1.4	0.291	1.03	0.315	Not Significant
Group-II	Males	38	6.2	1.1				
Group-I	Females	38	6.2	1.3	0.28	0.357	0.718	Not Significant
Group-II	Females	37	6.3	1.1				

Table 4- Comparison of Effect of Breath holding time (secs) in Group I and Group II

Groups		No. of Observations	Mean (x)	S.D.	S.E.	t- value	p-value	Significance
Group-I	Males	37	13.1	3.6	0.834	2.31	0.0005	Significant
Group-II	Males	38	15.44	3.62				
Group-I	Females	38	12.1	2.5	0.691	3.62	0.0004	Significant
Group-II	Females	37	14.6	3.4				

Table 5- Comparison of Effect of Respiratory rate in males and females

Groups		No. of Observations	Mean (x)	S.D.	S.E.	t- value	p-value	Significance
Group-I	Males	37	6.5	1.4	0.314	0.955	0.337	Not Significant
Group-I	Females	38	6.2	1.3				
Group-II	Males	38	6.2	1.1	0.254	0.393	0.689	Not Significant
Group-II	Females	37	6.3	1.1				

Table 6- Comparison of Effect of Breath holding time in males and females

Groups		No. of Observations	Mean (x)	S.D.	S.E.	t- value	p-value	Significance
Group-I	Males	37	13.1	3.6	0.717	1.393	0.164	Not Significant
Group-I	Females	38	12.1	2.5				
Group-II	Males	38	15.44	3.62	0.811	1.036	0.298	Not Significant
Group-II	Females	37	14.6	3.4				

Discussion

Results of the present study show that there was significant decrease in respiratory rate in males and females of both the groups. There was no significant difference in changes in respiratory rate observed in Groups - I and II indicating that TM and stress management programme are equally effective in reducing the respiratory rate. Similarly there was no significant difference in the effect caused in males and females indicating that sessions have same effect on males and females.

Paul Christoph et al [12], John Allison [13], Shirely Tells et al [14], Dan. C. Stanescu [15] D.D.S. Kulpati et al [16] and L.N. Joshi et al [17] also obtained significant decrease in respiratory rate as an effect of various yogic exercises.

In the present study Group I practiced TM for 6 week. Various workers have studied the effect of TM. John Allison [13] found significant decrease in respiratory rate during TM. Shirely Tells et al [5] demonstrated decrease in respiratory rate in volunteers mentally repeating a neutral syllable (which according to him is equivalent to TM) as compared to other volunteers who repeated meaningful syllable (OM). All his volunteers were experienced meditators. According to him there is increased neural activity while repeating a meaningful syllable and inhibition of neural activity while repeating a non meaningful syllable. TM is a wakeful hypo metabolic state characterized by drop in oxygen uptake, carbon di oxide excretion and minute ventilation. [18-24] It also causes reduced sympathetic activity. In a normal person increased sympathetic activity increases minute ventilation. Therefore reduced sympathetic activity due to practice of TM may be a factor in causing reduction in minute ventilation, BMR etc. Decrease in rate of respiration causes reduction in minute ventilation.

I. Sharma P.Singh [18] have also indicated tranquillizing effect of TM leading to decreased heart rate, decreased metabolism and increased skin resistance. Paul Christoph et al [12] have studied effect of single session of relaxation in which there is significant decrease in respiratory rate.

According to R.K. Wallace et al [25] during TM there is reduction in total ventilation caused either by decreased frequency or tidal volume.

David Orme Johnson et al [26] has stated that TM technique is a physiological state of restful alertness and it acts by preventing and accumulation of physiological stress and indirectly through improved lifestyle leading to balanced physiological functioning. However Shirely Tells et al [3] studied effect of 'OM' meditation on autonomic changes in meditators and found no significant reduction in respiratory rate during TM.

In the present study therefore significant decrease in respiratory rate can be explained on the basis of altered mental state, reduced sympathetic activity or inhibited neural activity.[5]

In the present study Group II practiced relaxation techniques,

asanas and breathing exercises in stress management programme for 6 weeks. Different relaxation techniques, asanas and breathing yogic exercises also have shown to produce significant reduction in respiratory rate [15-27] Dan. C. Stanescu et al [15] have studied the effect on volunteers doing hath yoga practice for a long period and found significant decrease in respiratory rate as compared to control group. Hath yoga practice involves control of posture and respiration. Authors say that respiratory exercises cause vagal blockage, which is responsible for reduced respiratory rate. Rate of breathing in eucapnic (having normal partial pressure of carbon di oxide level in blood) is determined by bulbopontine pacemaker mechanism. Modification in vagal afferent traffic sometimes gains predominance over the pacemaker and changes the rate. In hath yoga person practices slow, deep inspiration and expiration accompanied by apnoea. When tidal volume increases above normal pulmonary stretch receptors are stimulated and they send signal through vagi to increase the rate of respiration. In hath yogi repeated practice of such respiration and repeated stimulation of stretch receptor causes habituation of the reflex (Hering breuer reflex) which gradually reduces the afferent vagal traffic in response to stimulation of stretch receptors leading to a state of vagal blockade which is responsible for reduction in respiratory rate. Alternatively reduced sympathetic activity caused by various relaxation techniques is also responsible for reducing minute ventilation and respiratory rate [28] M. Satyanarayan et al [29] studied the effect of santhikriya which is a combined breathing and relaxation technique and found statistically significant decrease in respiratory rate after 30 days of practice of santhikriya. This indicated state of relaxation according to them. Shirely Tells et al [4] studied effect of breathing selectively through one nostril i.e. Anulom and Vilom type of pranayama and found that there is no effect of such respiratory exercises on respiratory rate but shows that breathing through right nostril increases sympathetic activity and breathing through left nostril reduces it. According to J.R Jennings et al [30] psychological factors do not only change sympathetic activity but also the vagal activity. Activation of either of these systems may influence only one site without influencing the other. Ayesha A. Khanam et al [27] did not find any reduction in respiratory rate in patients of asthma as an effect of yogasana and pranayama.

In the present study significant decrease in respiratory rate observed in volunteers who underwent stress management programme appears mainly due to relaxation technique of makarasana and jaw relaxation and other yogic asanas, which were done by them. With Anulom Vilom breathing some workers did not find any change in respiratory rate [4] but others had stated the reduced sympathetic activity after Anulom Vilom type of breathing exercises [27] Therefore reduction in respiratory rate in Group II appears to be mainly occurring as a result of relaxing effects of asanas and reduced sympathetic activity.

Whatever may be the cause of reduction in resting respiratory rate, which was noted after TM and stress management programme, it is beneficial as it reduces work of breathing and energy expenditure required for tidal respiration.

In the present study there was significant increase in breath holding time in males and females of both the groups. Comparing the effects in males and females of each group there was no significant difference indicating that change in breath holding time in males and females is almost equal. Comparing results in Group - I and Group - II it is observed that Group II volunteers have significantly greater increase in breath holding time as compared to Group - I volunteers. This denotes that stress management programme is more effective in increasing breath holding time. Similar results causing increase in breath holding time after yogic exercises is observed by many workers [31, 32]

Respiratory centre has both voluntary and involuntary control. Therefore respiration can be stopped voluntarily for a short period of time at any phase of respiratory cycle.

Various factors determine breath holding time –

Size of alveoli at the time of breath holding [31-33] i.e. breath holding time depends on initial lung volume. Breath holding time (BHT) is maximum when one holds the breath after full inspiration. Probably it is due to store of oxygen in the lungs at high lung volume.[32]

Break point in the breath holding time is due to several reasons. When person holds the breath, repetitive involuntary contractions of respiratory muscles begin early in breath holding. They increase in amplitude and frequency until break point and seem to be responsible for much of discomfort that is felt. These contractions of respiratory muscles activate receptors in the chest wall whose discharge is responsible for the conscious sensation of unpleasantness. Increase in lung volume would lessen the unpleasant sensation. The lower pressure at high lung volumes implies that receptors sensitive to pressure in the chest wall, lungs or upper air ways would be less stimulated. Since majority of activity at high lung volumes is inspiratory muscles, tension generated due to shortening of these would be less. Muscle and joint receptors affected by tension would be less stimulated when initial lung volume is high.

In the present study BHT after initial full inspiration was determined and therefore this probably is not the reason of increase in BHT observed. It is quite likely that increase in total lung capacity after the session might have caused comparatively increase in lung volume, initial to breath holding and may be a reason for observed increase in BHT. It is observed by Nayar et al [34] that yogic exercises cause significant increase in vital capacity.

Change in the sensitivity of respiratory centre- When breath is hold voluntarily, inhibitory impulses from higher centers are able to balance excitatory effects of increased levels of pCO_2, decreased levels of pO_2 and stimulation of stretch receptors. At the end of breath holding these impulses increase the sensitivity of respiratory centre to such a level that finally voluntary control breaks. TM decreases sympathetic activity which reduces the response of respiratory centre to carbon di oxide [15] this in turn causes increase in breath holding time.

According to A.S. Rebuc et al [35] breathing frequency lower than normal have reduced ventilatory response to carbon di oxide which is the cause of increase in breath holding time when respiratory rate is reduced.

Decreased responsiveness to chemoreceptors- Madanmohan et al [32] found increase in breath holding time in volunteers who did certain asanas for 12 weeks. As a result of yogic training there is decreased responsiveness of medullary and peripheral chemoreceptors which is responsible for increase in BHT.

During yogic exercises person is constantly controlling his/her respiratory muscles. In prolonged effect of controlling the respira-

tory muscles person consciously and persistently overrides the usual stimuli to respiratory center. [In the present study Group - II had performed Anulom Vilom type pranayama and therefore cause of increase in BHT may be attributed to training of respiratory centre to override the usual stimuli like increase in partial pressure of CO_2, decrease in partial pressure of O_2 and impulses from stretch receptors.]

In the present study in Group - I increase in BHT may be due to

1. Decreased sympathetic activity
2. Decreased rate of respiration leading to decreased sensitivity of respiratory centre to carbon di oxide and
3. Increase in initial lung volume due to increase in total lung capacity. Group - II additionally did respiratory exercises which were further responsible for better voluntary control over respiratory centre. This additional extra cause is probably responsible for significantly higher increase in BHT in Group - II volunteers than Group - I volunteers.

Conclusion

Both TM and stress management programme were effective in increasing the efficiency of respiratory system. Either of them therefore should be practiced regularly to prevent and treat psychosomatic respiratory disorders and other lung disorders.

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