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PULMONARY FUNCTIONS FOLLOWING YOGA IN A COMMUNITY DWELLING GERIATRIC POPULATION IN INDIA

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The usefulness of an ancient Indian intervention, Yoga to improve the pulmonary functions in a geriatric population was studied in a single blind, randomized controlled trial. 46 elderly inmates of a home for the aged, belonging to both genders were stratified and randomly allocated to two groups, a Yoga group and a Wait-list Control group. The pulmonary functions were assessed using a computerized spirometer at baseline and after three and six months of their respective interventions in both groups. The yoga group was given a combination of practices including physical postures, voluntarily regulated breathing, meditation, relaxation techniques and lectures on philosophy and practice of Yoga, while the Wait-list Control group continued with their normal routine. The data were analyzed using Repeated Measures ANOVA and t-test for paired data. The results suggested that there was a significant increase in the vital capacity of the yoga group, while there was a decrease in the vital capacity in the Wait-list Control group.

Key Words : pulmonary functions ; yoga ; wait-list control ; geriatric population

Many structural and functional changes have been reported to occur with aging, which influence the lung and chest wall function, gas exchange, and ventilatory control (Johnson, 2003). The most common changes include a stiffening of the chest wall (Rizzato & Marazzini, 1970; Morris, Koski, & Johnson, 1971), an apparent loss of respiratory muscle strength (Black & Hyatt, 1969), and a loss of elastic recoil of the lung tissue (Islam, 1980). Age associated changes in the respiratory system which may alter gas exchange include loss of elastic recoil (as mentioned above), a decreased surface area of the lung (Thurlbeck, 1980), decreased pulmonary capillary blood volume (Crapo, Morris, & Gardner, 1982), increased dead space ventilation (Martin, Das, & Young, 1979) and decreased distensibility of the pulmonary arterial vasculature (Reeves, Dempsey, & Grover, 1989). Studies have shown remarkable consistency in the qualitative changes of lung volumes with age (McClaran, Babcock, Pegelow, Reddan, & Dempsey, 1995). There is thought to be a period of plateau in vital capacity and FEV1 during early adulthood followed by a decline. Similar to the previously noted cohort effect for greater vital capacity, the age at which FEV1 begins to decline has been shifted to older ages with study of successive birth cohorts (Burrows, Lebowitz, Camilli, & Knudson, 1986;

Tager, Segal, Speizer, & Weiss, 1988). But longitudinal data from well-defined cohorts found that FEV_1 does not begin to decline until about the age of 36 years for both men and women (Burrows et al., 1986; Glindmeyer, Jones, Diem, & Weill, 1987). The decline in FVC is estimated to start in the mid-30s (Van Pelt et al., 1994; Dockery et al., 1985), with the most precise estimate being 39 years (95% confidence interval, 34-43 years) (Van Pelt et al., 1994).

Yoga is an ancient Indian science and a way of living. Yoga training for 6 months in 20 school children in the age group of 12 to 15 years has been shown to improve the maximum expiratory pressure (MEP), maximum inspiratory pressure (MIP), forced expiratory volume (FEV), forced expiratory volume in first second (FEV1) and peak expiratory flow rate (PEFR) (Madanmohan, Jatiya, Udupa, & Bhavanani, 2003). Another study suggested that 12 weeks of yoga practice can improve Forced Vital Capacity (FVC), FEV1 and PEFR in young females (age group 17-28 years) (Yadav & Das, 2001). Yoga has also been shown to improve the pulmonary functions in sports teachers who had been involved in physical training every day for nine years before the three month training in yoga (Telles, Nagarathna, Nagendra, & Desiraju, 1993). Apart from the benefits of yoga training in healthy volunteers, patients of bronchial asthma also benefited by practicing yoga. The benefits included a decrease in symptoms, need for medication and increased peak expiratory flow rate (Nagarathna & Nagendra, 1985). A Spirometric evaluation of persons with bronchial asthma following yoga showed a significant reduction in the symptom scores and improvement in PEFR and in absolute values of FEV1 and FVC from 15 days of practice onwards in males while female group showed significant changes only after 30 days. Also, the requirement of bronchodilators has reduced significantly in males after 30 days of practice (Murthy et al., 1984). Though it is evident from the above mentioned studies that yoga can be used as an effective intervention to improve pulmonary functions in both normal volunteers as well as in patients with bronchial asthma, its usefulness in a geriatric population has not yet been explored.

Hence, the present prospective, single blind, randomized control trial was designed to evaluate the effect of an ancient Indian science, Yoga in older persons.

METHODS

Subjects

120 inmates of a residential home for the aged, over the age of sixty years belonging to both sexes were examined. Thirty of them were ill or bed-ridden. The 90 subjects who expressed their willingness to participate in the trial were screened using: the electrocardiogram (all leads), fasting blood glucose, blood pressure measurements (using a sphygmomanometer), and routine clinical examination. The remaining 46 persons were told about the trial, i.e., that participants would be randomly

allocated to: Yoga or Wait-list control groups. All of them expressed their willingness to participate in the trial and the signed informed consent of each subject was taken.

Inclusion criteria: Subjects who had the following attributes were included in the study: (i) above the age of sixty years; (ii) belonging to both sexes; (iii) residing at the home for the aged for more than 6 months; (iv) healthy on a routine medical examination and on screening and (v) willing to participate in the trial by giving their signed informed consent.

Exclusion criteria: Subjects with the following conditions were excluded from the trial: (i) chronic ailments; (ii) disability or immobility; (iii) unwillingness to participate in the trial.

Following the detailed screening and routine clinical examination described above, subjects with the following health problems were excluded from the study: uncontrolled diabetes, uncontrolled hypertension, neurological disorders, dementia, hearing impairment, and a detected case of non-infective Hansen's disease. Forty six subjects were included for the study after this screening.

Design of the study

Subjects were assessed at baseline and after three and six months of their respective interventions (Yoga or Wait-list control).

Randomization: The 46 subjects were stratified according to age [five-year intervals, e.g., between 60 and 65 years (lower limit), and between 90 and 95 years (upper limit)]. Within a particular five-year age range, subjects of each gender separately, were randomized as two groups by the investigator (i.e., Groups 1 and 2) using a standard random number table (Zar, 1999). Allocation of a group to a particular intervention was carried out by the lottery method, as follows: The two interventions 'Yoga' or 'Wait-list control' were written on two similar pieces of paper which were folded. A person who had no other part in the trial, picked up and opened the folded papers. The first intervention to be picked up was assigned to Group 1, and accordingly for Group 2. Following stratified sampling and random allocation, there were 23 subjects in each group (including seven males in the Yoga group and six males in the Wait-list Control group) with average ages (± S.D) of 70.1 ± 8.3 and 72.3 ± 7.4 years, respectively.

Assessments

Pulmonary functions were assessed using a computerized spirometer (Schiller Spirovit Sp-1, Switzerland). Subjects were asked to sit at ease. Relevant information i.e., age, gender, height (in cm), and weight (in kg) was entered in the spirometer. Before each measurement the subjects were asked to breathe in and out through the mouth for three breaths. Instructions were given to hold the disposable mouth piece tight between the lips to avoid the leakage of air. A nose clip was used to ensure that they breathed through the mouth.

Each subject was instructed how to breathe during the following measurements: (i) Forced Vital Capacity (FVC): Subjects were asked to exhale as quickly as possible from the time of starting the test. (ii) Slow Vital Capacity (SVC): Subjects were instructed to breathe normally for three times and then inhale maximally to total lung capacity followed by maximal exhalation. (iii) Maximum Voluntary Ventilation (MVV): Subjects were asked to breathe as deeply and as rapidly as possible over a period of 6-12 seconds (maximal rapid inhalation and exhalation). (iv) Minute Ventilation (MV): Subjects were asked to breathe normally for one minute.

Data extraction

The following values were obtained as a computer printout from the computerized spirometer, i.e., (i) forced vital capacity (FVC), (ii) slow vital capacity (SVC), (iii) maximum voluntary ventilation (MVV), and (iv) expired or minute ventilation (MV).

Data analysis

Data were analyzed using the statistical package (SPSS Version 10.0). Repeated measures ANOVA was used to test for (i) significant differences between the assessments (i.e., baseline, three and six months) of both groups i.e., Within-Subjects factor and (ii) differences between the groups (Yoga and Wait-list Control) i.e., Between-Subjects Factor. The t-test for paired data was used to compare data at three and six months with those at baseline of each group, separately.

Interventions

Yoga training: Yoga is an ancient Indian science and way of life which brings about relaxation and also induces a balanced mental state (Taimini, 1986). Yoga techniques include physical postures (*āsanās*), voluntarily regulated breathing *(prāṇāyamās*), meditation, and philosophical principles which help to reach a balanced mental state.

The Yoga session was planned to include: physical activity, relaxation, regulated breathing and philosophical aspects of yoga. This was an integrated approach of yoga, derived from principles in ancient yoga texts which emphasize that yoga should promote health at all levels (Gambhirananda, 2002). This combination is believed to promote physical health (physical postures, loosening exercises and relaxation techniques), normal functioning at the subtle energy level (breathing exercises, voluntarily regulated breathing), mental and emotional level (meditation and devotional sessions) and at the intellectual level (lectures on philosophy of Yoga) (Nagendra & Nagarathna, 1985).

The session was for sixty minutes daily, for six days a week. Subjects practiced breathing exercises (10 min), loosening exercises (*sithilikaraṇa vyāyāma*, 5 min), physical postures (20 min), voluntarily regulated breathing (*pranāyāma*, 10 min) and yoga-based guided relaxation (15 min),

which has been described elsewhere (Vempati & Telles, 2002). There was an additional session in the evening which consisted of devotional songs (*bhajans*, 15 min) and lectures on theory and philosophy of Yoga alternating with 'cyclic meditation'. The last technique is derived from another ancient Indian text (the *māṇḍūkyopaniṣad*) and involves alternating cycles of physical postures and supine rest (Telles, Reddy, & Nagendra, 2000).

The Wait-list Control: The Wait-list Control group was not given any intervention but was told that they could receive Yoga after the trial. They were asked to continue with the normal routine of the home.

RESULTS

Forced Vital Capacity: The repeated measures ANOVA showed a significant difference between the groups ($F = 5.001$, $p < .01$, Greenhouse-Geisser epsilon = .893), and the interaction between the assessments and groups ($F = 4.333$, $p < .01$, Greenhouse-Geisser epsilon = .893) with no significant difference between the assessments.

The Yoga group showed a significant increase in Forced Vital Capacity by 31.82% ($p < .05$, paired t-test, baseline versus six months). In contrast and the Wait-list Control group showed a significant reduction in the Forced Vital Capacity by 35.63% ($p < .05$, paired t-test, baseline versus six months).

Slow Vital Capacity: The repeated measures ANOVA showed no significant difference between the assessments, between the groups and the interaction between the assessments and groups. The comparisons between the values at three and six months with their respective baseline values were not significant for both the groups ($p > .05$, paired t-test).

Maximum Voluntary Ventilation: The repeated measures ANOVA showed a significant difference between the assessments ($F = 6.018$, $p < .01$, Greenhouse-Geisser epsilon = .945). However, there was no significant difference between the groups or the interaction between the assessments and the groups.

The comparisons between the values at three and six months with their respective baseline values were not significant for both the groups ($p > .05$, paired t-test).

Minute Ventilation: The repeated measures ANOVA showed a significant difference between the assessments ($F = 8.040$, $p < .001$, Greenhouse-Geisser epsilon = .973), however, there was no significant difference between the groups, and the interaction between the assessments and groups.

The Yoga group showed a significant increase in the minute ventilation at three (51.47%) and six months (34.48%) ($p < .01$, $p < .05$, paired t-test, baseline versus three and six months respectively), while the Wait-list

Control group showed no significant change (*p* >.05, paired t-test, baseline versus three and six months).

The group mean ± S.D. for all the variables (i.e., FVC, SVC, MVV and MV) at baseline and after three and six months for both groups (Yoga and Wait-list Control) are given in Table 1.

	Yoga			Wait-list Control		
Variables	BL	3M	6M	BL	3M	6M
n	18	18	18	20	20	20
FVC (l/min.)	0.88 ± 0.40	1.00 ± 0.35	1.16* ± 0.49	0.87 ± 0.55	0.67 ± 0.36	0.56** 0.30
SVC (l/min.)	1.22 ± 0.49	1.49 ± 0.57	1.33 ± 0.54	1.28 ± 0.57	1.24 ± 0.6	1.20 ± 0.81
MVV (l/min.)	29.18 ± 9.33	32.39 ± 11.86	32.48 ± 12.6	25.98 ± 14.53	32.06 ± 17.34	26.99 ± 16.91
MV (l/min.)	6.70 ± 2.86	10.47 ± 5.92	9.01* ± 4.79	6.50 ± 4.44	8.80 ± 4.48	7.06 ± 4.56

* p<. 05, ** p< .01, two tailed, t-test for paired data comparing the values at three months versus baseline and six months versus baseline

DISCUSSION

The present study evaluated the pulmonary functions in community dwelling older persons following yoga compared to a Wait-list Control group. Six months of Yoga training has brought about significant changes in forced vital capacity and minute ventilation, while the Wait-list Control group showed deterioration in forced vital capacity.

In the Yoga group the minute ventilation increased by 51.5 percent at three months. The increase in minute ventilation in the Yoga group at three months may be due to an increase in the tidal volume rather than an increase in the breath rate. This may be speculated as a separate polygraph recording of the respiratory rate showed no change in either group (unpublished data).

The Yoga group also showed an increase in forced vital capacity by 31.8 percent. This suggested that lung volumes and capacities improved in the Yoga group after six months. Yoga training for 6 months has been shown to improve the maximum expiratory pressure (MEP), maximum inspiratory pressure (MIP), forced expiratory volume (FEV), forced expiratory volume in first second (FEV1) and peak expiratory flow rate (PEFR) in school children (Madanmohan, Jatiya, Udupa, & Bhavanani, 2003). Young females following 12 weeks of yoga practice showed improvements in Forced Vital Capacity (FVC), FEV1 and PEFR (Yadav &

Das, 2001). Yoga has also been shown to improve the pulmonary functions in sports teachers who had been involved in physical training every day for nine years before the three month training in yoga (Telles, Nagarathna, Nagendra, & Desiraju, 1993). Apart from healthy volunteers, patients of bronchial asthma also benefited by practicing yoga. The benefits included a decrease in symptoms, need for medication and increased peak expiratory flow rate (Nagarathna & Nagendra, 1985). While the mechanisms underlying these changes are not clear, the beneficial effects of Yoga can be attributed to increased strength of the respiratory muscles.

The Wait-list Control group showed a decrease in the forced vital capacity by 35.6 percent which may suggest that in the absence of interventions, respiratory function deteriorated though the magnitude of reduction needs to be understood.

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Table 1: Mean ± Standard Deviations of the pulmonary functions recorded at baseline (BL) and after three months (3M) and six months (6M) for both Yoga and Wait-list Control groups

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