



ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2016; 2(4): 130-134
www.allresearchjournal.com
Received: 22-02-2016
Accepted: 25-03-2016

Madhur Kulkarni
Post graduate
Student Chaitanya Medical
Foundation's College of
Physiotherapy, Pune.

Shilpa Parab
Professor & Principal
Chaitanya Medical
Foundation's College of
Physiotherapy, Pune,
Maharashtra, India.

Correspondence
Madhur Kulkarni
Post graduate
Student CMF's College of
Physiotherapy, Chinchwad,
Pune, Maharashtra, India

Effectiveness of respiratory muscle training along with aerobic training in community dwelling elderly individuals

Madhur Kulkarni, Shilpa Parab

Abstract

Background: Aging is associated with decline in performance of various systems resulting in reduced exercise capacity, fatigue and reduced respiratory muscle functioning. Studies reported that respiratory muscle training is effective to increase respiratory muscle functioning in various populations but the reports are limited in community dwelling elderly population.

Materials and methods: Thirty community dwelling elderly individuals fulfilling the eligibility criteria participated in a randomized controlled trial for four weeks of duration. They were assigned to Group A receiving respiratory muscle training along with aerobic training and Group B receiving only aerobic training. The outcome measures assessed were maximum voluntary ventilation, fatigue severity scale and 6 minute walk test distance; before and after four weeks of intervention.

Results: Statistically significant improvement was seen in maximum voluntary ventilation, fatigue severity scale and 6 minute walk test distance with $p < 0.0001$ in both the groups. Intergroup comparison showed greater improvement in the group A which received respiratory muscle training along with aerobic training.

Conclusion: Respiratory muscle training along with aerobic training was more effective than aerobic training alone in improving respiratory muscle function, fatigue and exercise capacity in community dwelling elderly individuals after four weeks of intervention.

Keywords: Respiratory muscle training, aerobic training, community dwelling elderly

1. Introduction

Age related physiological changes and sedentary lifestyle leads to a measurable decline in physiological functions leading to difficulties while performing the activities of daily living [1]. Structural changes in lungs results in decrease in the compliance of chest wall and lungs, also in strength and endurance of respiratory muscles, dilatation of alveoli leading to increase functional residual capacity and residual volume, decreased inspiratory reserve volume and vital capacity [2]. The structural and functional changes associated with aging results in reduced exercise capacity and increased load of respiratory muscles which results in fatigue [3]. The kyphotic curvature of the spine and increased AP diameter of the chest decreases the force-generating capacity of the diaphragm [4, 5]. Studies reported respiratory muscle weakness as an exercise limiting factor which may compromise blood flow to locomotor muscles reducing exercise performance and induce early fatigue [6, 7, 8].

Previous researches suggested Respiratory Muscle training (RMT) as an effective method to increase respiratory muscle functioning [9, 10, 11] as it improves strength and endurance of inspiratory muscles which delays the onset of respiratory muscle fatigue and improve the exercise tolerance [12, 13, 14].

Aerobic training (AT) is effective means of improving exercise capacity in the elderly [15, 16, 17]. Researchers have reported that AT improves respiratory muscle efficiency in healthy adults [18], obese individuals [19] and in elderly up to some extent [20].

But little information is available about the effectiveness of RMT with pressure threshold device as an adjunct to aerobic training on respiratory muscle performance in elderly individuals. The Powerbreathe® is a pressure threshold device functioning as a respiratory muscle trainer. Hence, the present study was aimed to determine the effectiveness of RMT with Powerbreath® and AT on respiratory muscle function, fatigue and exercise capacity in community dwelling elderly individuals.

2. Materials and methods

The study received approval from the Institutional Ethical Committee. Convenient sampling method was used. Participants were screened based on the inclusion and exclusion criteria described below. Those fulfilling the inclusion criteria were briefed about the nature of the study, and written informed consent was obtained. PAR Q and YOU questionnaire was administered and those who have said yes to one or more questions their Physician's consent was taken before starting the exercise programme. A general assessment of the cardiovascular, musculoskeletal and neurological systems was done.

The study was a randomized controlled trial. This was conducted in Physiotherapy OPD. Participants included were: Community dwelling elderly individuals, aged 60 to 75 Years (Both male and female), having BMI < 30 kg/m² with fatigue level ≥ 4 on Fatigue severity scale, Maximum Voluntary Ventilation (MVV) reduced $\geq 30\%$ predicted, willing to participate. Participants were excluded if they had: cardiovascular abnormality where exercise training was contraindicated (Unstable Angina, Systolic blood pressure >180, Recent Myocardial Infarct), impaired cognitive function, unable to participate in the exercise training protocol due to an orthopaedic or neurological limitation, pulmonary diseases.

Eligible participants were assigned to a group A that received respiratory muscle training along with aerobic training (n=15) and group B that received only aerobic training (n=15) by permuted block allocation. The participants were blinded to the intervention; physiotherapists were not blinded because they had to schedule the intervention.

Outcome measures used were MVV to assess the respiratory muscle performance. Six-minute walk test to assess the exercise capacity. The highest reported reliability for this measure is 0.94 [21]. Fatigue Severity Scale (FSS) was used to assess the fatigue. The internal consistency of the FSS, according to Chronbach's alpha was 0.93 for older persons [22]. The demographic data, Maximum voluntary ventilation (MVV), Fatigue Severity Scale (FSS), 6-min walk test distance (6MWTD), were assessed before and immediately after 4 weeks of intervention.

The equipments used for the study were, 'Powerbreathe[®]' i.e. the pressure threshold device used as a respiratory muscle trainer, classic series with Medium resistance' manufactured by HaB International, UK. The spirometer used for the for Pulmonary function tests was Spirotech, version 1.1.0.20 © 2010, Clarity Medical Pvt. Ltd., Cones and measuring tape for marking distance during the six minute walk test, Sphygmomanometer and stethoscope for measurement of BP. The Polar Heart Rate Monitor manufactured by Polar Electro Oy. Certified ISO 9001:2000 was used during the aerobic session to monitor the heart rate attained during each stage of the test. Cycle ergometer used for aerobic training was Cosco[®] CEB TRIM 222 D Exercise Bicycle.

2.1. Intervention

Participants in group A performed respiratory muscle training with Powerbreathe[®] 5 times per week for 4 weeks i.e. 20 sessions composed of 30 sets of inhalation and exhalation two times in a session [23] lasting 10-15 minutes, followed by the aerobic training session.

Participants in both the groups performed aerobic training for 5 days a week for 4 weeks. Exercise intensity was determined by -

Karvonen's Method for Calculation of Target Heart Rate Range with % Heart Rate Reserve (HRR): [24, 25]

Target Heart rate range = 50% to 70% [HRmax – HRrest] + HRrest

Where HRmax=220-age

Aerobic training was preceded by warm up which included mild stretching of large muscles groups. Then they received aerobic training on cycle ergometer with an intensity of 50% of HRR initially, then gradual progression till 70% of HRR by the end of 4 weeks. The duration of each session was 30-45 minutes, including 10 minutes warming up, 20-25 for active stage of training on cycle ergometer and 10 minutes cooling down which included slow cycling and stretching of large muscle groups.

3. Results

The present study included 30 community dwelling elderly individuals with a mean age of 66.03±2.78 years. The demographic characteristics of the participants in both the groups revealed that both the groups were comparable (Table 1). Baseline comparison of outcome measures showed no significant differences in both groups. All the participants completed 4 weeks of intervention. No adverse events were noted during the study period.

In group A, intragroup comparison by paired t test showed significant improvement in mean values of MVV and 6 MWTD while fatigue was significantly reduced according to Wilcoxon Ranking test (Table 2, Figure 2, 3 and 4 respectively).

Also intragroup changes in group B were significant after 4 weeks of intervention (Table 3, Figure 2, 3 and 4 respectively).

Between group comparison showed that there were highly significant differences in both groups after 4 weeks of intervention. MVV and 6 MWTD were significantly improved according to unpaired t test and fatigue reduction did not show significant difference in both groups according to Mann-Whitney U test. (Table 4, Figure2, 3 and 4 respectively).

Table 1: Demographic profile of both the groups

Parameters	Group A mean	Group B mean	p value
Age (Years)	65.8±3.65	66.26±1.62	0.654
Height (cm)	164.9±9.39	168.4±5.79	0.233
Weight(Kg)	64±7.71	64.86±6.84	0.747
BMI(kg/m ²)	23.7±3.05	22.95±1.67	0.382

Table 2: Comparison of outcomes in group A pre and post intervention

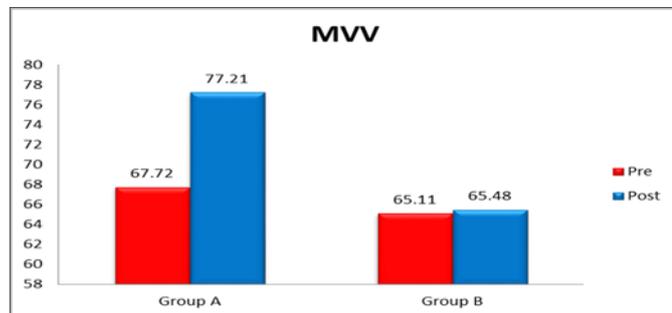
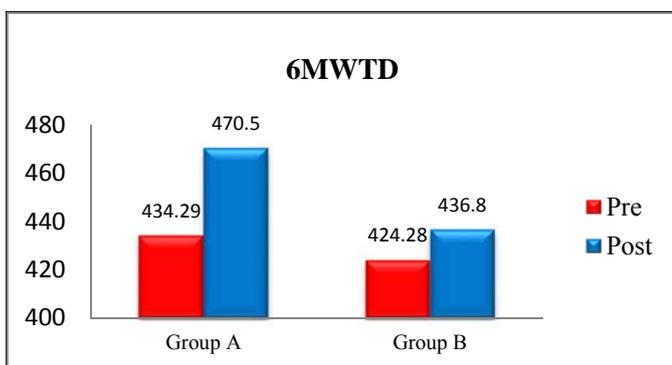
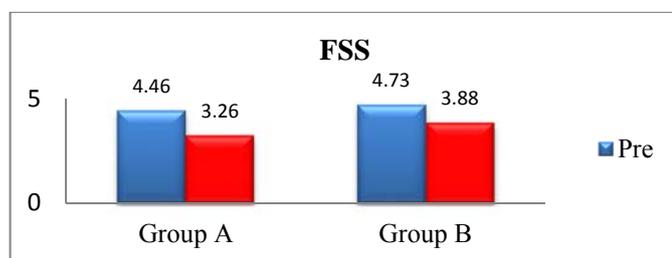
Group A	Pre	Post	T	P
MVV(L/m)	67.72±8.41	77.21±7.48	17.6	<0.0001
6MWTD	434.29±57.86	470.5±55	23.6	<0.0001
FSS	4.46±0.44	3.26±0.48	-	<0.0001

Table 3: Comparison of outcomes in group B pre and post intervention

Group B	Pre	Post	T	P
MVV(L/m)	65.11±9.47	65.48±9.37	2.91	0.01
6MWTD(m)	424.28±30.3	436.8±28.5	12.32	<0.0001
FSS	4.73±0.41	3.88±0.23	-	<0.0001

Table 4: Between group comparison of outcomes in group A and B post intervention

	Group A	Group B	T	P
MVV(L/m)	77.21±7.48	65.48±9.37	16.54	<0.0001
6MWT(m)	470.5±55	436.8±28.5	10.43	<0.0001
FSS	3.26±0.26	3.88±0.23	-	0.0026

**Fig 1:** Comparison of MVV in both groups**Fig 2:** Comparison of 6 Minutes' Walk Test Distance in both groups**Fig 3:** Comparison of FSS in both groups

4. Discussion

The result of this study showed significant improvement in maximum voluntary ventilation, exercise capacity and reduction in fatigue after 4 weeks of intervention in both the groups. But group A (RMT+AT) was significantly better than the group B (AT).

Possible explanation of the improvement in MVV is increase in respiratory muscle efficiency. Respiratory muscle training with Powerbreathe® along with aerobic training might have strengthened the respiratory muscles more effectively than aerobic training alone. While, reduction in air trapping, improvement in lung compliance and reduced airway resistance are the possible effects of respiratory muscle training [26, 27].

Another study by Ramirez-Sarmiento *et al.* provides the evidence that RMT induces structural adaptations within the inspiratory muscles like an increase in the proportion of type I fibres and size of type II fibres which increases the fatigue resistance by reducing the force of contribution from each

active myofibers at a given submaximal level of ventilation. Also, a stronger type I fibres may allow delayed recruitment of the type II fibres [28]. Improvements in AT group may be due to improved aerobic endurance and ventilator muscle function, increased motivation [29, 30].

Fatigue was significantly reduced in both the groups. Carlos a. Vaz fragoso *et al.* has reported that age related decline in FVC, expiratory volume and maximum voluntary ventilation can lead to fatigue. Therefore, since respiratory muscle training improves MVV, it might also contribute to decrease in fatigue [3]. Romer *et al.* suggested another explanation for reduced fatigue that the concomitant increase in limb blood flow would increase oxygen delivery to limbs decreasing the blood lactate concentration [31]. Thus the result of this study support the statement given by H.J. Shin *et al.* that pulmonary physical therapy is needed for the elderly to enhance respiratory efficiency and reduce fatigue [32].

In the current study, exercise capacity was found to be significantly increased in both the groups. This result can be attributed to aerobic conditioning which results in metabolic and circulatory adaptations that can contribute to improvements in skeletal muscle function and exercise capacity [33]. Similar results were reported in a study done by Dale Lovell *et al.* that there was a significant increase in leg strength, leg power, leg muscle mass, and VO₂max after giving aerobic training with a bicycle ergometer in older adults [34].

In this study, the group A was better than the other group in improving the exercise capacity. This is in accordance with the study of Aron S. Buchman *et al.* who stated that the impaired respiratory muscle strength and endurance results in inadequate energy supply leading to decreased exercise capacity which can be prevented and reversed by inducing respiratory muscle training [35]. During aerobic exercise, minute ventilation increases and an overload is placed on the respiratory muscles which leads to increased frequency and the speed of muscle contraction [36].

Mcconell summarizes reasons for performance-enhancing effects of RMT which includes improved breathing pattern and delayed respiratory muscle fatigue [37, 38, 39] a redistribution of blood flow from respiratory to locomotor muscles and a decreased perceptions of respiratory and limb discomfort and fatigue during exercise [40, 41].

The concomitant effect of the study includes psychological wellbeing and increased social interaction of the participants. There was a tendency for intervention group A to perform better than control group B in all participant rated outcomes.

5. Limitations

Limitations of the study include small sample size of and long term follow up of the participants was not taken. In Future a study can be done with larger sample size and long term follow up in different populations. Comparison between different pressure threshold devices manufactured by different companies can be done as a study.

6. Clinical implication

This involves recommendation of Respiratory muscle training along with aerobic training can be as a part of geriatric exercise programme. This will add life to years in elderly individuals and help in maintaining functional status which is affected due to aging.

7. Conclusion

Respiratory muscle training combined with aerobic training was more effective than aerobic training alone in improving

respiratory muscle function, fatigue and exercise capacity in community dwelling elderly individuals.

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