International Journal of Health Sciences and Research
Vol.10; Issue: 3; March 2020
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Respiratory Muscle Stretch Gymnastic in Elderly: Impact on Maximum Breathing Capacity, Peak Expiratory Flow Rate and Exercise Capacity

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ABSTRACT

The availability of better medical care and rising health awareness has led to an increase in the geriatric population in the past century. With an increasing age, degenerative changes occur in the body which affect the musculoskeletal and respiratory system as well. There are different types of exercises, mobilisations and respiratory muscle training techniques which have been employed to improve respiratory functions of the aging lung. Respiratory muscle stretch gymnastic (RMSG) is one such technique.
Aims and Objectives: To study the impact of respiratory muscle stretch gymnastic on maximum breathing capacity, peak expiratory flow rate, exercise capacity, rate of perceived exertion and posture in healthy elderly population.
Method: A total of 82 subjects in age group of 60-70 years were selected according to the inclusion and the exclusion criteria. They were asked to perform RMSG exercises for 4 weeks. An assessment of maximum breathing capacity, peak expiratory flow rate, exercise capacity, rate of perceived exertion and posture was done pre and post training.
Results: The results indicated that there was an improvement in maximum breathing capacity, peak expiratory flow rate and exercise capacity (p=0.00). The rate of perceived exertion after 2-minute walk test was reduced (p=0.00). Significant improvement in neck posture (p=0.002) and upper back posture (p=0.00) was also noted.
Conclusion: The study concluded that the practice of RMSG exercises by the elderly subjects led to an improvement in their maximum breathing capacity, peak expiratory flow rate, exercise capacity, rate of perceived exertion and posture.

Key Words: Respiratory muscle stretch gymnastic, elderly, maximum breathing capacity, peak expiratory flow rate, 2 minute walk test

INTRODUCTION

Better medical care and rising health awareness has led to an increase in the geriatric population in both the developed and developing countries. In the past 50 years the Indian population over the age of 60 years (i.e. the elderly) has almost tripled in numbers. (Government of India, 2011). This pattern is poised to continue and the number of elderly in India is assumed to reach 158.7 million in 2025. [1] A study in 2006 stated that 75 percent of the Indian population is suffering from a chronic illness which requires lifelong medication. [2] Therefore, in coming years, a challenge lies in front of health care providers to ensure good quality of life for the elderly population and to make ageing a successful process.

"Ageing" has been defined as the gradual biological impairment of normal function due to changes made in cells and structural components. [3] When it comes to the respiratory system, the natural process of ageing includes muscle imbalances, structural changes in the musculoskeletal system due to geometric modification of the rib cage along with reduction in chest wall compliance. [4] This restricts the mobility of the rib cage and increases the breathing-related energy expenditure. This leads to increased fatigue and stiffness of these muscles and thus again the pulmonary function is compromised.

When a muscle loses its normal flexibility, the length-tension relationship is altered. This prevents the muscle from reaching sufficient peak tension leading to muscle weakness and retraction. [5] This muscle shortening can result from various factors, such as incorrect postural alignment, immobilization, muscle weakness and aging. In themselves, muscle fibers are incapable of lengthening, which requires an external force applied to the muscle. [6] Muscle stretching is a resource that is widely used in rehabilitation programs, since it can prevent injuries and increase flexibility. [7] Thus, stretching exercises of the respiratory muscles may improve respiratory muscle functions in the elderly group of population.

There are different types of exercises, mobilisations and respiratory muscle training techniques which have been employed to improve respiratory functions of the aging lung. Respiratory muscle stretch gymnastics (RMSG) is one such technique. Conventionally, the stretching and breathing exercises are given separately, but in RMSG stretching and breathing exercises are clubbed together. Thus, RMSG is an emerging technique for respiratory muscle conditioning. RMSG is a group of stretching exercises sequentially performed to stretch specific muscles involved in respiration. It stretches the external intercostal muscles during inspiration and the internal intercostal muscles during expiration, which aims to reduce chest wall stiffness. [8]

Minehiko Yamada et al. (1996) studied benefits of Respiratory Muscle Stretch Gymnastics in COPD patients and concluded that RMSG is safe and effective conditioning method to improve the pulmonary function and reduce dyspnoea in COPD patients. [8] Minoru Ito et al. (2000) studied the immediate effect of Respiratory Muscle Stretch Gymnastic on the respiratory pattern in COPD patients and concluded that it has a beneficial effect on the respiratory pattern. [9] Nobuka Aida et al. (2002) studied effect of Respiratory Muscle Stretch Gymnastic in post coronary artery bypass grafting (CABG) patients and concluded that it is useful in pulmonary rehabilitation, improves exercise capacity, mood and quality of life and also shown decreased level of pain in post CABG patients. [10] MathurSurbhi et al. (2012) have shown that respiratory muscle stretch gymnastics improves quality of life in COPD patients. [11] These studies which have reported the beneficial effect of RMSG to improve pulmonary function and reduction of dyspnoea in different group of populations. But there is a paucity of studies on effect of RMSG on the healthy elderly group of population.

The aim of the study was to study the impact of RMSG exercises on maximum breathing capacity, peak expiratory flow rate, exercise capacity and posture in elderly population.

The objectives of the study were to assess the impact of RMSG exercises on the following parameters in the elderly population:

1. Maximum breathing capacity: using ‘three minute respiratory exerciser test’ (3-MRET) by Incentive spirometer.
2. Peak expiratory flow rate using the Wright peak flow meter.
3. Exercise capacity with the help of 2 minute walk test.
4. Rate of perceived exertion with the Modified Borg scale.
5. Neck and upper back posture.

If this technique is improving the pulmonary function then it is advisable to practice RMSG exercises for the elderly population. By using RMSG at an early stage, we can help reduce overall effect of respiratory muscle stiffness in the elderly which will prevent reduction in pulmonary function in later years. This will help the elderly to maintain a comparatively healthy and more functional lifestyle. Thus, if effective, it can be included as an exercise approach for improving lung function and well-being in elderly population.

MATERIALS AND METHODS

Approval of ethics committee was sought for this quasi-experimental study. Convenience sampling was used. A total of 112 subjects were screened and 82 were selected according to the inclusion and exclusion criteria described in the study. Out of which 65 persons completed the study duration of 4 weeks. 17 persons withdrew from this study, 5 had acute infections and 12 persons discontinued due to other personal commitments due to which there was a loss to follow up. A written consent was taken from them after explaining the study procedure. Assessment and documentation of subject's maximum breathing capacity, peak expiratory flow rate, exercise capacity, rate of perceived exertion and posture was done pre and post training.

Inclusion Criteria:

1. Elderly individuals of age group 60-70 years
2. It includes both males and females
3. Stable vitals at rest
4. Willingness of the subject to participate in the study

Exclusion Criteria:

1. Acute infection or any recent illness
2. Presence of any major musculoskeletal, cardiovascular or neurological condition limiting cognition and mobility
3. Prior training of breathing exercise or yoga

The maximum breathing capacity, peak expiratory flow rate, exercise capacity, rate of perceived exertion and posture were assessed pre and post training as follows:

Assessment of Maximum breathing capacity (MBC) (Figure 1): Maximum breathing capacity was assessed using '3-minute respiratory exerciser test' (3MRET) by using triflow incentive spirometer. Columns A, B and C of incentive spirometer required flow rates of 600 ml/min, 900 ml/ min and 1200 ml/min respectively to bring the balls to reach the top, and as such, required the generation of sufficient inspiratory effort on the part of the subject to achieve this. The subjects were seated comfortably and the spirometer was held in front of them to provide visual feedback. They were asked to inhale forcefully through the mouth piece of the spirometer for 3 minutes continuously with the aim to lift as many balls as possible with each inspiration. The number of times the subjects were able to lift the balls in 3 minutes was documented and the MBC score was calculated by using the formula:

MBC score = (number of times that all three balls reached the top of columns) x 2 + (number of times that two balls reached the column top) x 1.5 + (number of times that only one ball reached the column top) x 1. [12]

Figure 1. Assessment of Maximum breathing capacity

Assessment of Peak expiratory flow rate (PEFR) (Figure 2): Peak expiratory flow rate was measured with the help of wright peak flow meter. The subjects were seated comfortably on a chair. The procedure was explained to them. They were asked to inhale deeply through the nose then exhale as forcefully as possible in the mouth piece of the peak flow meter. The procedure was repeated three times and the best of the three readings was documented.

Figure 2. Assessment of Peak expiratory flow rate

Assessment of Exercise capacity: Exercise capacity was determined with the help of 2 minute walk test. [13]

2 minute walk test (Figure 3): The procedure was explained to the subjects. They were asked to walk continuously for 2 minutes on a 10 meters path at a self-chosen pace. Encouraging words were given after every 30 seconds. They were observed from behind and not by walking besides them. They were given a pre test practice session of 2 minute walk test and after an interval of 15 minutes, the 2 minute walk test was performed and the distance achieved in two minutes was documented in meters.

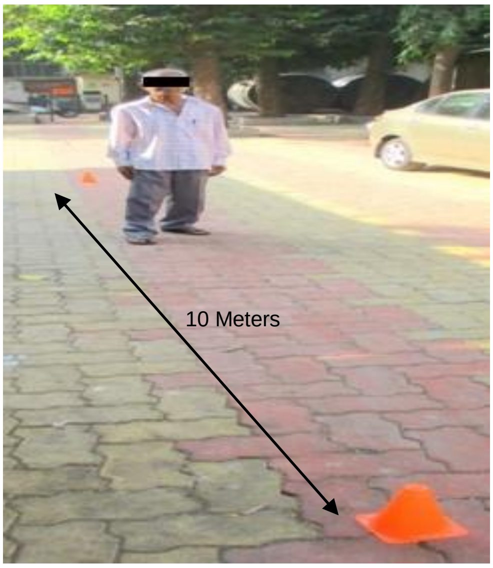

Figure 3. 2 minute walk test

Assessment of Rate of perceived exertion (RPE): Rate of perceived exertion was documented after the 2 minute walk test using the modified Borg scale which is a quantitative indicator of perceived exertion. The scale was explained to the subjects. They were asked to mark their rate of perceived exertion on the scale after the 2 minute walk test.

Assessment of Posture (Figure 4): Posture was examined in the lateral and posterior view with the help of a plumb line and measuring tape. The subjects were asked to adequately expose the part for taking the measurements. They were asked to stand straight and look forward with arms relaxed by the side and feet slightly apart. The neck posture was assessed by measuring the distance from the tragus of the ear to the acromion process (D1) with the measuring tape. The upper back posture was assessed with the plumb line being suspended from an overhead bar, the plumb bob hung in line with the midline of the subject and the distance from the inferior angle of scapula to the plumbline as midline (D2) was documented.

Figure 4a Measuring D1 **Figure 4b Measuring D2**

Figure 4. Assessment of Posture

Performance of Respiratory muscle stretch gymnastic:

After the initial assessment, the subjects were taught the RMSG exercises by giving a brief description along with demonstration of the RMSG exercises. An information leaflet containing instructions for performing RMSG along with the picture of the RMSG exercises were handed over. Neither the speed nor the duration of the movements was specified. The RMSG exercises were performed in standing position. The subjects were asked to perform 4 sets of these exercises for 4 weeks, 6 days a week and 3 times daily. Once a day the exercises were performed under supervision and then the subjects were asked to perform these exercises on their own for the other two times. Record of the performance of the exercises for the other two times in a day was kept by means of telephonic intervention.

Procedure [8] :

The following four patterns of RMSG exercises were performed:

RMSG No. 1 (Figure 5): Start with a relaxed position with a straight back (Figure 5a). Slowly elevate both shoulders while moving them backwards. At the same time, lean back while inhaling (Figure 5b). After full inspiration, exhale slowly, relax and resume original position.

Figure 5a Starting position **Figure 5b End position**

Figure 5. RMSG No. 1: Elevating and pulling back the shoulders

RMSG No. 2 (Figure 6): With the back straight, hold both hands at the back of the buttocks (Figure 6a). After full and slow inspiration, push the hands away from the body while slowly exhaling (Figure 6b). After full expiration, breathe quietly and resume original position.

Figure 6a Starting position | **Figure 6b End position**

Figure 6. RMSG No. 2: Stretching the upper chest

RMSG No. 3 (Figure 7): With the back straight, hold both hands in front of the chest with the fingers entwined and the palms in (Figure 7a). Inspire fully in this position. Then extend the arms and bend the upper body as far forward as possible while exhaling slowly (Figure 7b). After arm extension and body bending, take a full breath in that position. Then breathe quietly and resume original position.

Figure 7a Starting position | **Figure 7b End position**

Figure 7. RMSG No. 3: Stretching the back muscles

RMSG No. 4 (Figure 8): With the back straight, hold both hands above the head with arms stretched and palms facing down (Figure 8a). After full inspiration in this position pull the arms back while exhaling slowly (Figure 8b). After full expiration, resume original position and breathe quietly.

Figure 8a Starting position | **Figure 8b End position**

Figure 8. RMSG No. 4: Stretching the lower chest

STATISTICAL ANALYSIS

The data collected was analysed using SPSS 20 software. The data was tested for normality using the Shapiro-Wilk test. The paired t-test, which is a parametric test, was used to analyze the data passing the normality test whereas the Wilcoxon Signed Rank test, which is a non-parametric test, was used to analyze the data not passing the normality test. The level of significance was set as 5%.

The data of MBC score and PEFR passed the normality test. Thus the pre and post data of MBC score and PEFR was analyzed using the paired t-test. The data of 2 minute walk distance (2MWD), rate of perceived exertion (RPE) score and assessment of neck posture and upper back posture did not pass the normality test. Thus the pre and post data of 2MWD, RPE and posture was analyzed using the Wilcoxon Signed Rank test.

RESULTS

Table 1: Gender distribution of the subjects

	MALE	FEMALE
TOTAL NUMBER	28	37
PERCENTAGE	43.08%	56.92%

The above table showed the gender distribution of the subjects recruited in the study. A total of 28 males and 37 females participated in this study which accounted for 43.08% and 56.92% respectively.

Table 2: Age distribution of the subjects

	Age groups			
	61-65 years		66-70 years	
	Males	Females	Males	Females
	20	22	8	15
Total	44		23	

The above table showed the distribution of subjects in different age groups. The mean age of the participants was 64.50±2.68 years.

Table 3: Comparison of Maximum Breathing Capacity pre and post intervention

The pre and post comparisons of MBC score was done using the paired t-test as the data passed the normality test.

Descriptive statistics

	Mean	N	Std Deviation	Std Error Mean
Pre	95.03	65	23.08	2.86
Post	109.96	65	23.55	2.92

Paired Sample Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	SD	Std Error Mean	95% CI of the difference				
				Lower	Upper			
Pre test-Post test	-14.93	8.78	1.08	-17.10	-12.75	-13.70	64	0.00 ($p<0.05$)

The table showed that there was an improvement in MBC score of subjects post intervention which was statistically highly significant ($p<0.05$). This indicated that RMSG helped in improving the MBC of the subjects.

Table 4: Comparison of Peak Expiratory Flow Rate pre and post intervention

The pre and post comparison of PEFR was done using the paired t-test as the data passed the normality test.

Descriptive statistics

	Mean	N	Std Deviation	Std Error Mean
Pre	251.69	65	53.117	6.588
Post	278.83	65	49.666	6.160

Paired Sample Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	SD	Std Error Mean	95% CI of the difference				
				Lower	Upper			
Pre test-Post test	-27.13	12.7	1.57	-30.28	-23.98	-17.21	64	0.00 ($p<0.05$)

The table showed that there was an improvement in PEFR of subjects post intervention which was statistically highly significant ($p<0.05$).This indicated that RMSG helped in improving the PEFR of the subjects.

Table 5: Comparison of 2 minute walk distance (2MWD) pre and post intervention

The pre and post comparison of 2MWD was done using Wilcoxon signed rank test as the data did not pass the normality test.

	Mean	SD	Standard Error	Median	Wilcoxon signed rank test (W)	p value
Pre	105.48	13.57	1.68	108.00	-7.013	0.00 ($p<0.05$)
Post	118.81	14.06	1.77	121.00	Difference is significant	

The table showed that there was an increase in 2 minute walk distance post intervention which was statistically highly significant ($p<0.05$). This indicated that RMSG helped in improving the exercise capacity of the subjects.

Table 6: Comparison of rate of perceived exertion (RPE) pre and post intervention

The pre and post comparison of modified Borg's score was done using the Wilcoxon Signed Rank Test as the data did not pass the normality test.

	Mean	SD	Standard Error	Median	Wilcoxon signed rank test (W)	p value
Pre	0.58	0.52	0.06	0.50	-5.287	0.00 ($p<0.05$)
Post	0.22	0.22	0.04	0.00	Difference is significant	

The table showed that there was an improvement in Borg's score post intervention which was statistically highly significant ($p<0.05$).This indicated that RMSG helped in reducing the RPE of the subjects.

Table 7: Comparison of distance from tragus of ear to acromion process (D1) pre and post intervention

The pre and post comparison of D1 was done using the Wilcoxon Signed Rank Test as the data did not pass the normality test.

	Mean	SD	Standard Error	Median	Wilcoxon signed rank test (W)	p value
Pre	19.74	1.10	0.13	19.80	-3.174	0.002 ($p<0.05$)
Post	19.63	1.09	0.13	19.50	Difference is significant	

The above table showed a reduction in D1 post intervention which was significant statistically (p<0.05). This indicated that RMSG helped in improving neck posture of the subjects.

Table 8: Comparison of distance from inferior angle of scapula to plumb line (D2) pre and post intervention

The pre and post comparison of D2 was done using the Wilcoxon Signed Rank Test as the data did not pass the normality test.

	Mean	SD	Standard Error	Median	Wilcoxon signed rank test (W)	p value
Pre	9.40	0.66	0.08	9.50	-5.01	0.00 (p<0.05)
Post	9.22	0.71	0.089	9.20	Difference is significant	

The above table showed a reduction in D2 post intervention which was statistically highly significant (p<0.05). This indicated that RMSG helped in improving the upper back posture of the subjects.

DISCUSSION

Maximum Breathing Capacity (MBC):

The study concluded that there was an improvement in the MBC score of subject's post intervention which was highly significant statistically (p=0.00<0.05).

Nobuaya Miyahari et al concluded that 3 weeks pulmonary rehabilitation program, comprising of RMSG and cycle ergometer exercise improved the MBC, 6 minute walk distance test and quality of life in patients with COPD. In our study also we found that the MBC increased post RMSG training of 4 weeks.

In studies on animal models, it was possible to analyze the muscle fibers. A study has shown that performing stretching exercises once a week in shortened muscles was sufficient to reduce muscle atrophy. [14] Some authors have reported that, in normal muscles submitted to stretching exercises three times a week, there is a serial increase in the number of sarcomeres and in the cross-sectional area of the muscle fibers. [15-16] Therefore, the increased muscle force due to stretching might be attributable to better interaction between the filaments of actin and myosin, by virtue of the increase in the functional length of the muscle. [6]

In one study, it was reported that the generation of tension in the skeletal muscle (which is determined by evaluating the length-tension relationship), is directly correlated with the degree to which actin and myosin filaments are superimposed, less superimposition of these filaments in the muscle at rest translating to greater capacity of the muscle to generate tension. [17]

The RMSG exercises used in the present study indeed promote such an alteration in the interaction between the filaments of actin and myosin and, consequently, improved the contractile capacity of the respiratory muscle group. Another aspect relevant is the possible serial increase of the number of sarcomeres, which might have promoted the increase in the contractile capacity of this muscle group. Thus, these mechanisms can explain an increase in the MBC.

Peak Expiratory Flow Rate (PEFR):

There was an improvement in PEFR of subject's post intervention which was highly significant statistically (p=0.00 <0.05).

Minehiko Yamada et al. studied benefits of Respiratory Muscle Stretch Gymnastics in COPD patients. The study results suggested that RMSG immediately reduced dyspnea at rest, and improved spirometric variables including forced vital capacity (FVC) and PEFR in patients with severe COPD. In our study also we found an improvement in PEFR and decrease in Borg's score after RMSG training.

PEFR is a measure of maximum expiratory flow rate sustained by a subject for at least 10 ms starting from the level of maximum lung inflation expressed in liters/minute (l/min). [18] It is an important parameter of pulmonary function test and it reflects mainly the caliber of the bronchi and larger bronchioles, which are subjected to reflex broncho constriction. It is a good indicator of respiratory efficiency as it denotes the expiratory flow rate during the peak of FVC. Thus, the flow rate is a function of lung volume rather than the effort exerted, which is why it is 'effort - independent flow' and is significantly increased in our study group. Gulderen Sahin et al reported that the stretch receptor reflex decreased the tracheal smooth muscle tone. [19] This in turn leads to decreased airway resistance and increase airway caliber, increasing the PEFR.

It has been reported that elderly people have lower chest wall compliance than younger people. Although the chest wall compliance was not measured in the present study, it seems reasonable to assume that the elderly people in the present study had stiff chest walls, including the respiratory muscles. Hagbarth et al. reported that muscle stretching causes a decrease in finger flexor stiffness. [20] Therefore, it is possible that respiratory muscle stretching similarly affected chest wall compliance and decreased chest wall stiffness. Studies have reported that if the respiratory muscles are stretched to their full extent, the respiratory apparatus is able to work to their maximal capacity. [21-24] the increase in PEFR might also be explained by this mechanism.

Stretching stimulates muscle spindles and due to alpha-gamma linkage, the sensitivity of muscle spindles is increased during contraction. [25] Thus, stretching the contracting muscle is a powerful stimulus for the muscle spindles. Kanamaru et al. recorded electromyographic activity from respiratory muscles and reported that activity during RMSG is greater than that during deep breathing alone, indicating that RMSG stimulates muscle spindles. [26] Thus increased the force generated during respiration by the muscles, improving the PEFR.

Thus RMSG exercises must have decreased the tracheal smooth muscle tone improving the airway calibre and increasing the PEFR post RMSG training. Along with it, the generation of powerful stimulus for the respiratory muscle spindles and thus the improved efficiency of the respiratory apparatus also explained the increased PEFR post RMSG training.

Exercise Capacity:

There was an increase in 2 minute walk distance post intervention which was highly significant statistically (p=0.00 <0.05), suggesting that there was an improvement in subject's exercise capacity after RMSG training.

A walking test can be a good measure of "functional exercise capacity", defined as patient's ability to undertake physically taxing activities encountered in everyday life. Hideko Mineguchi et al reported a significant improvement in the 6MWD and reduction of functional residual capacity (FRC) in patients with chronic obstructive pulmonary disease (COPD) after RMSG training of 4 weeks.

The FRC is increased in old age as compared to younger population. [4] The resultant hyperinflation thus increases the metabolic cost of breathing. [27] Some studies have reported that an increased FRC is likely to be associated with increased dyspnea intensity during exercise. [28-31] The reduction in FRC following RMSG could thus explain the greater distance walked during the 2MWD as well as the reduction in dyspnea per distance walked. It is likely that with reduced FRC at rest after RMSG, FRC at a given distance was also reduced. This may have played a role in increasing the 2MWD and reducing the RPE post RMSG training.

Rate of perceived exertion (RPE):

There was an improvement in modified Borg score post intervention which was highly significant statistically (p=0.00<0.05), suggesting that there was a reduction in subject's RPE post RMSG training.

Studies have reported that the "In phase vibration" (IPV), or alternating vibration applied to the contracting intercostal muscles, decreases dyspnea. [32-

33] This effect has been suggested to be physiologic, since out-of-phase vibration, or alternating vibration applied to the non-contracting intercostal muscles, increases dyspnea. [26] The dyspnea-decreasing effect of IPV is probably mediated by vibration-elicited afferent activity from chest wall respiratory muscle receptors to supraspinal centers. These afferents could be from muscle spindles, since vibration is a powerful stimulus of the muscle spindles. [34]

Similarly, stretching also stimulates muscle spindles and the sensitivity of muscle spindles is increased during contraction. [25] Thus, RMSG may increase afferent activity from the contracting chest wall respiratory muscle spindles to the supraspinal centers in a manner similar to IPV. This powerful stimulus from the stretching of contracting respiratory muscles and the reduced FRC may have resulted in reduced RPE post RMSG training.

Posture:

There was a reduction in the distance from the tragus to acromion process (D1) post intervention which was significant statistically ($p=0.002<0.05$), suggesting that there was an improvement in the subject's neck posture post RMSG training. Also there was a reduction in the distance from the inferior angle of scapula to the plumb line (D2) post intervention which was highly significant statistically ($p=0.00<0.05$), suggesting there was an improvement in the subject's upper back posture post RMSG training.

In the geriatric population, as the age increases there are muscle imbalances and structural changes in the musculoskeletal system. There is chest wall stiffening and compliance of chest wall is decreased due to calcification of the costal cartilages and chondrosternal junctions. This stiffness of the chest wall leads to tightness of the respiratory muscles, which further restricts the mobility of the rib cage. [35] The above changes lead to increased forward head posture and increased kyphosis of the dorsal spine. This bad posture becomes a habit with time if not taken care of.

The forward head posture is considered to co-exist with hyperextension of the upper cervical spine, flattening of the lower cervical spine, rounding of the upper back, and elevation and protraction of the shoulders (Darnell 1983, Kendall and McCreary 1983, Rocabado 1983). [36] This implies that the subjects are more bended forward which places the neck extensors, anterior chest wall muscles as well as the abdominal muscles in a shortened position.

Excessive cervical lordosis causes shortening of the neck extensor muscles. RMSG 3 involved extending the arms and bending the upper body forward with complete neck flexion. The practice of this position may have indirectly lengthened the shortened neck extensor muscles and thus reduced the excessive cervical lordosis.

Similarly, the rounded shoulders and kyphotic attitude in the elderly places the pectoralis major and minor as well as abdominal muscles in a shortened position. Long term adaptation to this position leads to their tightness. RMSG 1 involved elevating both shoulders while moving them backwards during inspiration while leaning backwards and RMSG 2 involved holding both hands at the back of the buttocks and after full and slow inspiration, pushing the hands away from the body. These two positions put the pectoralis major and minor muscles in a relatively lengthened position. The RMSG position 4, which involved holding both hands above the head with arms stretched and after full inspiration pulling them backwards had put the abdominals in a relatively lengthened position. This may have helped in lengthening these muscles thus reducing the rounded shoulder posture.

The long term practice of 4 sets of RMSG (4 weeks, 3 times a day) could have lead to repeated stimulus from the muscle fibres to the higher centres which helped in regulating the correct postural mechanisms. This may have conditioned the subjects and helped in adaptation of the corrected posture. Thus, the decreased D1 (distance from the tragus to the acromion process) and D2 (distance from the inferior angle of scapula to midline) can be contributed to the above mechanisms.

It can be thus concluded that in this study there is significant improvement in the MBC, PEFR, exercise capacity, RPE and posture post RMSG training in the elderly population.

Limitations:

1. Small sample size.
2. All the samples collected were from one institution, the results cannot be generalized for the entire population.

Suggestions:

1. A large multi centric study should be conducted so that the results can be generalized to population.
2. Large sample size can be studied.
3. Long term effects can be studied.

CONCLUSION

The study concluded that after the practice of Respiratory Muscle Stretch Gymnastic (RMSG) program for 4 weeks by the elderly subjects of 60-70 years; there was a significant improvement in all the parameters in this study.

Clinical Significance: The study presents new RMSG exercises which may be an initial step toward future treatments of the elderly population. The program of physical exercise designed to stretch respiratory muscles improved not only MBC, PEFR and exercise capacity but also reduced dyspnea and improved posture. RMSG can thus be employed as a novel method for stretching chest wall muscles. It is a simple and easy exercise program to perform without much assistance. Thus RMSG can be used as an effective modality of treatment along with the conventional therapy in the Indian elderly population. This program may represent yet another valuable tool in rehabilitation of elderly.

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How to cite this article: Hetal M, Ashok BP. Respiratory muscle stretch gymnastic in elderly: impact on maximum breathing capacity, peak expiratory flow rate and exercise capacity. Int J Health Sci Res. 2020; 10(3):145-158.

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