

Effects of Sub Maximal Progressive Resisted Exercises on the Functional Outcome in the Institutionalised Elderly Population

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ABSTRACT

Background and Purpose – Muscle weakness, particularly of lower limbs, is associated with reduced walking speed, increased risk of falls and disability in elderly. Though Progressive resisted exercises has been proved to increase muscle strength in elderly there is uncertainty about its dosage and its effect on balance, mobility and depression in elderly. The objective of the study was to know if there is any improvement in balance, mobility, depression on the Berg balance scale, Timed Up and Go test and Geriatric Depression Scales respectively after the intervention program.

Methodology- After taking ethical committee permission and informed consent from participants, 38 subjects, mean age, (71.97±4.87) years, ambulatory with or without walking aid were recruited in the study from two old age homes. The study design was within group pre-post experimental design. The study was single blinded to reduce the bias. The participants were given sub maximal (30-70% of 1 R M) Progressive resisted exercises to lower limb muscles - ankle dorsiflexors, plantar flexors, hamstrings, quadriceps, hip abductors and hip extensors with free weights (in the form of sand bags). The total duration of the study was ten weeks. ACSM guidelines for strength training were followed. The outcome measures of the study were Berg Balance Scale, Timed Up and Go test, Geriatric Depression Scale. After completion of the study, the collected data was statistically analysed.

Results- Statistical analysis was done by using paired t test for Timed Up and Go test, scores of Berg balance scale and Geriatric depression scale were analysed using Wilcoxon signed rank test. All the parameters scores on Berg balance scale ($z = -5.659$, $p = 0.00$), Timed Up and Go test ($t = 17.66$, two tailed significance of 0.00), Geriatric depression scale ($z = -5.659$, $p = 0.00$) showed significant improvement post intervention.

Conclusion - Sub maximal Progressive resisted exercises (30 to 70 % 1 RM) is an effective and safe exercise program to improve balance, mobility and depression in institutionalised elderly.

Key Words: Sub maximal, Progressive Resisted exercises, Institutionalised, balance, mobility, depression.

INTRODUCTION

As age advances degenerative changes of the body also increases. The age related deterioration in sensory, motor functions has been established. ⁽¹⁾ Musculoskeletal weakness has been cited as one of the most common causes of disability

in community predisposing adults to falls and activities of daily living. Deconditioning physical inactivity or chronic diseases can result in reduced strength, power, endurance and flexibility which results in decreased functional performance. These consequences can have

a profound effect on ability of adults to lead their functional independent lives.

Sarcopenia can be defined as the age related loss of muscle mass, strength and function. ⁽²⁾ Although there is no specific level of lean body mass or muscle mass at which one can say sarcopenia is present, any loss of muscle mass is important because there is a strong relationship between muscle mass and strength. ⁽³⁾ Sarcopenia appears to begin in the fourth decade of life and accelerates after the age of approximately seventy five years. ⁽²⁾ Research indicates that many factors including physical inactivity, motor unit remodelling, decreased hormone level and protein synthesis contribute to sarcopenia.

A decrease in muscle protein synthesis will result in loss of muscle mass. Muscle regeneration and growth of muscle tissue requires the assistance of satellite cells. Satellite cells are specialised cells located in the basal membrane of muscle cell and are necessary for development of new muscle tissue. The number of satellite cells in skeletal muscle decreases as an individual ages, providing possible mechanism of muscle mass and strength. ⁽³⁾

The more an individual leads an inactive and sedentary lifestyle the more disabled he or she becomes. Such disability can be classified as disuse atrophy. The existence of two detrimental factors in same person as muscle loss, loss of strength has been shown to have a compounding effect. Uncompensated loss of muscle strength can result in spiralling decline of functional independence.

The importance of strength training was first proposed by Young in a concept called Threshold value. ⁽⁴⁾ Since the De Lorme and Oxford systems of training were first introduced, numerous variation of Progressive resisted exercises protocol have been proposed and studied to determine an optimal intensity of resistance training, number of repetitions, sets, frequency and optimal progression of loading. The health benefits associated with Progressive Resisted Exercises make it useful

intervention in physical therapy. Though PRE has shown to benefit elderly people in terms of improving muscle strength, there is uncertainty about how these effects translate into changes in substantive outcomes like improving mobility and balance. Also there is uncertainty about relative benefits of sub maximal PRE compared to other exercise program or effectiveness of varying dose of PRE (varying doses of intensity and duration). Most studies demonstrate response to training with moderately high loads (more than 40 % of 1 RM). Studies in which minimal weights were used or loads were not progressively increased to increasing strength were not as effective. ⁽⁵⁾

Research has shown that high intensity machine based (more than 80% of 1 RM) strength training can have profound effect on functional independence of elderly. But high intensity machine based training is not feasible to all elderly. Thus a low cost and feasible sub maximal (low to moderate intensities) using free weights was designed to improve lower body strength and to see whether it has any effect on balance, mobility and depression in elderly population.

AIM & OBJECTIVES

AIM- To study the effects of Sub maximal Progressive resisted exercises on the functional outcome in the institutionalised elderly population.

OBJECTIVES – To know if there is any improvement in balance on Berg balance scale

To know if there is any improvement in mobility on Timed Up and Go Test.

To know if there is any reduction in depression on Geriatric Depression Scale.

MATERIALS AND METHODOLOGY

Materials-

Free weights (in the form of sand bags)

Goniometer

Ruler

Two standard chairs with arm rests

Foot stool

Stop watch or wrist watch

Measuring tape

Assessment Proformas

Berg Balance scale- The tests uses 14 items to measure balance of older adults in clinical settings. The equipment needed are ruler, 2 standard chairs(with and without armrest), footstool, stop watch, fifteen feet walkway. The completion time is 15 to 20 minutes. A five point ordinal scale ranging from 0 to 4 indicates low level of function and 4 indicates high level of function. Total score is 56. The interpretation is 41 to 56 – low risk of fall, 21-40 as medium fall risk, 0 to 20 as high fall risk. The test has 91% sensitivity and 82% specificity. ⁽⁶⁾

Timed Up and Go Test-It modifies the original get up and go test by adding time component to performance. (Podsiadlo and Richardson).Patients are timed in seconds when performing the tests. It has three conditions –

TUG alone – from sitting in chair, stand up, walk 3 meters, turn around, walk back and sit down.

TUG cognitive – complete the task while counting backwards from randomly selected number between 20 and 100.

TUG manual – complete the task while carrying full cup of water.

The cut off levels for TUG is 13.5 seconds or longer with an overall correct prediction rate of 90%, the sensitivity and specificity is 87 %. ⁽⁷⁾

The Geriatric Depression Scale – The GDS, long form is a brief ,30 item questionnaire in which participants are asked to respond by answering Yes or No., in reference to how they felt over the past week. Scores 0 - 9 means normal, 10-19 means mild depression and 20-30 indicates severe depression. I t has 92% sensitivity, 89% specificity when evaluated against diagnostic criteria. ⁽⁸⁾

Methodology – Permission to carry out the study was taken from ethical committee and authorities of old age homes. The study design was within group pre post experimental design. The participants recruited in the study were institutionalised

elderly, 65 years and above who met the study inclusion criteria. The inclusion criteria were Institutionalised elderly, males and female, 65 years and above, ambulatory with or without walking aids. The exclusion criteria was those having unstable cardiac or respiratory conditions, subjects having cognitive impairments, history of Osteoarthritis of knee joint- having pain more than 5 on Visual Analogue Scale and those taking antidepressants.

Consent was taken and information about the study programme was given to the participants. Before beginning the strength training programme, assessment of the participants and pre test score of the outcome measures were documented. The study was single blinded to reduce the bias. It was a group therapy exercise class where sub maximal progressive resisted exercises (30 to 70 % of 1 RM) were given to lower extremity muscles. ACSM guidelines for strength training in elderly were followed. The exercise session lasted for about 40 to 50 minutes including warm up and cool down period of five to ten minutes. The strength training was given for three days in a week with a rest day in between to reduce the chances of muscle soreness and injury. The total duration of the programme was for ten weeks. The targeted muscles of lower extremity were hip extensors, hip abductors, quadriceps, hamstrings, ankle dorsi flexors and plantarflexors.

In the first two weeks, 30% of 1 RM, was used to strengthen lower extremity muscles. The number of sets per each exercise was three. The number of repetitions in each set was 10.The strength training programme was progressed to 60% of 1 RM by the end of eight weeks. Thus by the end of 10 weeks, strengthening was progressed to 70% of 1 RM. After completion of interventional programme, the baseline scores of balance, mobility and depression were documented by second evaluator. Out of total 38 participants, 34 subjects completed the study. The reason for drop outs were -2 subjects went out of station, 1 subject showed lack of interest to

continue and 1 reported mild illness. No injuries were noted after completion of the study intervention. The data was collected and then results were drafted after doing statistical analysis.

Statistical Analysis

Mean and Standard deviation were calculated for all the variables.

The data was analysed using SPSS version 10.

Timed up and go test readings for mobility was analysed by using paired t test.

Berg balance scale and Geriatric depression scale was analysed using Wilcoxon signed rank test.

RESULTS

Total numbers of subjects in the study were 38.34 subjects completed the study and statistical analysis was done for 34 subjects.

Table 1 shows gender wise distribution of the total participants .11 males and 23 females participated in the study.

Gender	Number of subjects
Male	11
Female	23

Table 2 denotes the ambulatory status of the participants . Out of 34 subjects, only 8 participants were using assistive devices.

Walking Aids	Number of subjects
With	8
Without	26

All the subjects were ambulatory. 8 subjects were using assistive devices and 26 were ambulating independently.

Table 3 denotes age wise distribution of the study participants. The mean age of the participants was 71.97+ 4.87 years.

65-75 years	25
76-85 years	9
85 years and above	0

Table 4 denotes representation of pre test and post test values of balance on Berg balance scale.

Time of assessment	Mean	S D	z value	p value
Pre	32.29	6.04	-5.65	0
Post	42.76	5.65	-5.65	0

BBS showed significant improvement post intervention .It was analysed using Wilcoxon signed rank test.

Table 5 denotes representation of pre and post test values of mobility on Timed up and Go test.

Time of assessment	Mean	SD	t	Two tailed sig.p
Pre	18.81	5.26254	17.166	0.00
Post	12.32	3.86327	17.166	0.00

There was significant improvement in post Timed Up and Go test and was analysed using paired t test.

Table 6 denotes representation of pre and post test values of depression on Geriatric Depression scale.

Time of assessment	Mean	S D	z	2 tailed significance
Pre	18.29	3.503	5.65	0.00
Post	11.38	2.944	5.65	0.00

Post geriatric depression score showed improvement post intervention, z= -5.65, p = 0.00. It was analysed using Wilcoxon signed rank test.

DISCUSSION

This study reveals that older people can experience large improvement in muscle strength, particularly if their muscles are significantly overloaded during training. Despite evidence of benefit from PRE in terms of improving muscle strength, there was uncertainty about the effectiveness of varying doses of PRE (varying intensity and duration). Hence this study was carried to study the effects of sub maximal PRE on the

functional outcomes-balance, mobility and depression among institutionalised elderly.

Effect of PRE on balance- The score of balance on Berg balance scale improved significantly post intervention as compared to pre intervention strength training programme. Foot problems are common in older people and are associated with impaired balance, functional mobility as compared to those who did not fall. Fallers exhibit decreased ankle flexibility, decreased plantar tactile sensitivity, decreased plantarflexors strength. To prevent a fall after tripping over an obstacle high demands are posed on the strength of lower limb muscles. Thus the supporting

limb plays an important role in balance recovery by generating appropriate joint movement during push off. As strength declines with age (due to muscular tendinous and neural alterations, leg muscle strength might be the limiting factor in preventing fall.

Older adults use more of co activation pattern of muscle compared with the orderly sequence of distal to proximal activation seen in younger adults. Older adults are more likely to use hip strategy or proximal to distal activation of muscles rather than typical strategy to control the sway. ⁽⁹⁾ This may be related to decreased strength and flexibility at ankle. Changes in fibre type, especially type 2, have been linked to dramatic decline in the generation of high frequency postural muscle contraction. ⁽¹⁰⁾ Thus strengthening ankle dorsiflexors and plant flexors must have led to greater moment generation, improved strategies and thus improved balance in our present study.

Effect of PRE on mobility – The score of mobility on TUG test, improved significantly after ten weeks of PRE programme. Gait velocity at comfortable walking speed begins to change slightly when adults are in their 60s and 70s. The difficulty with maintaining maximum walking speed is related to older adults' inability to generate peak ankle plantar flexor moment as younger adults. They rely instead on increasing hip flexion power to increase the speed. ⁽¹¹⁾ Strengthening exercises have been shown to increase walking speed, cadence, and stride length of older adults. Increased cadence was found to be related to increased ankle dorsiflexion, whereas increased stride was found to be related to increased hip extension strength. ⁽¹²⁾ Decreased plant flexor strength has also been taught to reduce step length and increase time in double support. The task of rising from seated position is often associated with falling in elderly. ⁽¹³⁾ The elder people spend more time in initial phase of rising from chair. They flexed their legs and trunk more during the trials in

which they used no hands to help themselves. Studies have shown that the peak vertical momentum of Centre of mass in elderly was smaller than young adults because of low level of strength in older adults. Thus strengthening of lower extremity muscles in the study must have increased the ability of sit to stand, improve the walking speed and improve the scores of mobility on TUG scale.

Effect of PRE on depression-The study participants showed improvement in depression on GDS after ten weeks of exercise programme. The reasons for reduction in depression could be that resisted exercises could have released growth hormones and monoamines that help in fighting depression. ⁽¹⁴⁾ Also the duration of the study was for ten weeks, which meant it could mimic the trials of antidepressant medications which show effect within 6-8 weeks. As it was a group exercise session, improvement in depression could be attributed to psychosocial factors like learning new exercises, socialising, increased social interaction.

Study Limitations-

No follow up was carried after ten weeks of intervention program. So long term effects of progressive resistance training on balance, mobility, depression cannot be studied. So, further research is needed to be carried out with follow up about carry over effect of this training.

As there was no uniformity in the number of participants in each age group, it was not possible to predict which age group –young old, middle old or old benefitted from this intervention.

Future Scope - A control group could be added and functional activities could be incorporated along with strength training in the present study.

Clinical Implication-

Physiotherapist can advise and consider sub maximal (low to moderate intensity) PRE strength training programme using free weight (in the form of sand bags) as low

maintenance and cost effective means of training in elderly to increase functional independence and psychological health.

CONCLUSION

Thus sub maximal Progressive Resisted Exercises (30-70% of 1RM), 3 days per week for ten weeks can improve balance, mobility and depression among institutionalised elderly.

It is advisable that the elderly participants after following structured exercises can still maintain the increase in the strength by doing them at low doses (once or twice) a week.

List of Abbreviation Used-

1 RM- 1 Repetition maximum.
PRE –Progressive resisted exercises.
BBS-Berg balance scale
TUG-Timed Up and Go test.
GDS- Geriatric Depression Scale.

Competing Interest- None.

Authors' Contribution

Dr Sheetal Aurangabadkar (PT)- conceived, designed, acquired the data, analysed the data, drafted the manuscript submitted for the publication.

Dr Nilima Bedekar (PT) - Guided and supervised the study throughout from its design to manuscript submission, approval for manuscript submission.

Ashok Shyam – guided in statistical analysis and research related to the study.

Dr Parag Sancheti – Final approval and permission from the institute for publication of manuscript.

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