Original Article

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Physiotherapy Section

Effectiveness of Quadriceps Resistance Training on Physical Function of Elderly People

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ABSTRACT

Introduction: Aging is commonly associated with decreased muscle size, strength and less force production in elderly people. Loss of skeletal muscle mass, strength and quality have fatalistic impacts on their physical activity. Weakness of the lower extremities (especially quadriceps muscle) has been associated with difficulties in getting up from the bed and rising from the chair, slower walking, altered balance and increased risk of falls. These functional alterations can lead to decreased physical activity independence. The quadriceps force production is decreased with increase in age and affects the daily routine activity of elderly which creates much complication and thereby more socio-economic expenditure.

Aim: To find out the effect of Quadriceps resistance with flexibility exercise on physical function of elderly subjects.

Materials and Methods: A Pre and Post experimental study design with a total of 70 subjects with age of 60-85 year were divided into 35 participants in experimental group who received quadriceps resistance training with flexibility exercises and 35 participants in control group who received flexibility exercises alone for 12 weeks study duration. Pre-test and post-test Quadriceps strength was measured using isometric push pull dynamometer and also timed up and go test was done for physical function of participants in both the groups respectively. Paired t-test was used to examine the impact of intervention among the variables.

Results: The quadriceps strength had pre-test values of 26.77±2.30 and post-test value of 42.17±5.56 in experimental group, pre-test value of 26.34±1.11 and post-test value of 28.00±2.47 in control group. The physical function with pre-test values of 17.69±2.63 and post-test value of 7.97±1.03 in experimental group, pre-test value of 17.37±2.30 and post-test value of 14.00±1.24 in control group. Experimental group showed significant changes ($p<0.05$) among the variables when compared with the control group.

Conclusion: Quadriceps resistance exercise was shown to be more effective mode of intervention along with the flexibility exercise on physical function of elderly people. Thus, the implementation of resistance training of quadriceps will prevent the age-related sarcopenia and improve the physical function of elderly.

Keywords: Aging, Exercise intervention, Geriatric population, Sarcopenia

INTRODUCTION

The number of older adults is expected to nearly triple from 2010 to 2050 globally [1]. Aging is integrated with sarcopenia, which is defined as the depletion of muscle size and strength [2,3]. The quantity of muscle fibers in the muscles depletion with aging, describes the loss of muscle mass [4]. Additionally, these age-associated structural changes within the older adult muscles are associated with less force production. Loss of skeletal muscle mass, strength and quality have fatalistic impacts on physical activity. Weakness of the lower extremities has been associated with difficulties in getting up from the bed and rising from the chair [5,6], slower walking [7], altered balance and increased risk of falls [8]. These functional alterations can lead to decreased physical activity independence [9]. In previous study, the authors have ruled out the effect of lower limb muscle strength on physical ability and found that mostly the quadriceps muscle strength is a key variable [10]. In one of the study, they have recognised that the quadriceps muscle weakness is an important factor in the occurrence of falls among nursing home residents [8]. Also, the increased knee extension torque to rise from a low chair than from a higher chair and during fast rising compared to slow has been reported [11]. Some of the authors found out that the quadriceps muscle strength decreased with aging among elderly people. This results in increase in duration to perform the timed up and go test [12,13]. Physical activity is often recommended to prevent disability and maintain physical function. Specifically, resistance training has been recommended as an intervention strategy for improving muscle strength and muscle power, two factors known to impact physical function in older adults [14]. In other study, the author has suggested that, the elderly person and feeble individuals will improve their muscle strength if they have been trained at the above sub-maximal intensity of one repetition maximum [15]. The role of quadriceps muscle in lower extremity has been playing a vital role for physical function. Due to aging process, the quadriceps muscles get changed accordingly and it is the primary cause for physical inactivity and community isolation in elderly. Isolated quadriceps resistance training and its impact on physical function of elderly were lacking in current scenario and thus we have considered this lacunae in the research as a motivation behind this present research proposal. In this study, we have set a research hypothesis to determine whether the quadriceps resistance exercise along with the routine flexibility exercise can alter the physical function of the elderly people.

MATERIALS AND METHODS

This study had a pre and post experimental design and aimed to determine the effectiveness of quadriceps resistance exercise on physical function of elderly people and the results have been compared with the control group. The study was conducted between January to August 2017. The data were collected at out-patient physiotherapy department, Mohamed Sathak AJ College of Physiotherapy. The participants who could walk independently without the use of assistive devices and were between 65-80 years of age were included. Participants with uncontrolled hypertension, a history of cardiovascular disease, neurological disease, chronic or significant respiratory disease, inflammatory arthritis, muscle disease were not included. Also, patients with history of quadriceps

tendon rupture or patellar fracture, who received corticosteroid injection to the quadriceps muscle or patellar tendon within one year, were long-term users of corticosteroid medication, or were currently participating in a regular strengthening exercise program were excluded from the study. The Institutional ethical committee (EC/PT/17/008) approved the study procedure and all the subjects signed an informed consent form before participating in the study. A pilot study was conducted for calculating the sample size for this current research proposal before getting ethical approval from the ethical committee. From the pilot study result of physical function outcome measures using n power test (n=85%), the effective sample size for this present study as 70 participants was calculated. Initially, 110 participants within the age group of 65-80 years were recruited and after the evaluation of study criteria, 40 participants were excluded. After getting the consent, the total of 70 participants were allocated using simple random sampling method into group A (Experimental group, n=35) and group B (Control group, n=35) respectively.

The intervention protocol for group A and group B are mentioned in the [Table/Fig-1,2] respectively [14]. Quadriceps muscle strength was measured using make test [16]. The isometric test was performed on a push pull handheld dynamometer (500 lb). Participants were in high sitting with knee flexed to 90° and the cushioned pad of dynamometer was placed proximal to the malleolus. Participants were asked to exert as much force as possible while trying to extend the knee against the equal pressure given in opposite direction by the assessor. The participants performed two warm-up submaximal isometric contractions followed by two maximal isometric contractions by each leg. Each contraction was held for five seconds and there was a 30 second rest between repeated contractions. The highest maximum of the two isometric contractions was selected for each leg, and then the average maximum isometric contraction of both legs was calculated and used in the analysis [17]. Physical function was assessed using the timed up and go test. For the timed up and go test, the subjects sat on a standard height chair with armrests. On the command "go" they stood up and walked 3 m (to a mark on the floor), turned around, walked back to the chair and sat down. A stopwatch was used to measure the time from the command "go" to the time when the subject sat down [5]. Participants performed one practice trial followed by two test trials. The trial with the shortest time was used in the analysis.

Exercise regimen	Duration	Sets	Sessions
1. Warm-up free exercises to the lower extremity muscles.	40 minutes	3 sets (15 repetition each set)	4 days/ week
2. Walking for 5 minutes.			
3. Relaxed Breathing exercise.			
4. Active stretching exercises to the hamstring, calf, and gluteal muscles.			
5. Isolated quadriceps strengthening with submaximal training intensity of 1RMusing weighing cuffs.			
6. Progress to 90% of 1RM training intensity.			

[Table/Fig-1]: Exercise protocol for participants in group A.

Exercise regimen	Duration	Sets	Sessions
1. Warm-up free exercises to the lower extremity muscles.	40 minutes	3 sets (15 repetition each set)	4 days/ week
2. Walking for 5 minutes.			
3. Active stretching exercises to the hamstring, calf, and gluteal muscles.			
4. Relaxed Breathing exercise			

[Table/Fig-2]: Exercise protocol for participants in group B.

STATISTICAL ANALYSIS

The data was analysed using SPSS version 17 for social science. The paired t-test was used for comparing the effectiveness of both the group before and after intervention with significance level of $p<0.05$.

RESULTS

Seventy elderly subjects participated in this study (males 70%). Participant baseline characteristics of age (74±1.50), height and weight with male/female ratio of 42:28 are provided in [Table/Fig-3]. The results of the comparison of both the group participant physical function with pre-test values of 17.69±2.63 and post-test value of 7.97±1.03 (Group-A), Pre-test value of 17.37±2.30 and post-test value of 14.00±1.24 (Group-B) and quadriceps muscle strength with pre-test values of 26.77±2.30 and post-test value of 42.17±5.56 (Group-A), Pre-test value of 26.34±1.11 and post-test value of 28.00±2.47 (Group-B) are presented in [Table/Fig-4,5] respectively. The participants involved in the quadriceps resistance exercises along with the flexibility exercises showed significant improvement ($p<0.05$) compared to the participants with flexibility exercise alone.

Baseline data	Mean±SD	
Age	74±1.50	
Height in centimetres	155±2.55	
Weight in Kilograms	69±1.75	
Gender	42 males	28 females

[Table/Fig-3]: Baseline characteristics of study participants (N=70).

Timed up and go test in seconds	Group A (Mean±SD)	Group B (Mean±SD)	t-value	p-value
Pre-test values	17.69±2.63	17.37±2.30	0.837	0.202^{NS}
Post-test values	7.97±1.03	14.00±1.24	-23.704	0.001**

[Table/Fig-4]: Comparison of pre and post-test values of timed up and go performance among group A and B participants.
NS: Not significant, **Significant

Quadriceps muscle strength in lb	Group A (Mean±SD)	Group B (Mean±SD)	t-value	p-value
Pre-test values	26.77±2.30	26.34±1.11	1.372	0.087^{NS}
Post-test values	42.17±5.56	28.00±2.47	29.588	0.001**

[Table/Fig-5]: Comparison of pre and post-test values of quadriceps muscle strength among group A and B participants.
NS: Not Significant, **Significant

DISCUSSION

In this study, the quadriceps muscle resistance training along with flexibility exercise was examine on improvement of physical function of elderly participants compared with the flexibility exercises alone. The physical performance of participants with quadriceps resistance training and flexibility exercises assessed using timed up and go performance has shown greater improvement in duration when compared to the flexibility exercise alone (p-value=0.001). Similarly, the quadriceps muscle strength also shows much better improvement in participants after the intervention of resistance training with flexibility exercises than the flexibility exercise alone (p-value=0.001). Altubasi IM et al., states that age related decreased muscle size and wasting of the muscle fibers can lead to the reduced muscle strength and thereby it affect the routine activity performance of elderly [18]. Even, from this study it was found that the physical performance of participants showed significant improvement after the quadriceps resistance exercise along with flexibility exercise. Goodpaster BH et al., describes in healthy older adults that decreased quadriceps muscle strength with age progress [19]. Marcell TJ et al., also proved that even the endurance trained older adults also got significant reduction in the quadriceps and hamstring muscle strength after a five year duration

[20]. In older people, the muscles having an increased stiffness in the myofilament may be a mechanism underlying reduced muscle contraction efficiency [21]. Dias CP et al., also stated that peak power in lower extremities was closely related with limitations of function and self-reported difficulties in community-based men and women [22]. Both muscle strength and power were vital for the daily routine task of elderly and its reduction due to aging was important predictor tool of individual performance [15]. Csapo R et al., have suggested that, when the training stimulus is of 70-90% of the One-Repetition Maximum (1RM) intensity, increase in muscle strength and size in older healthy and frail individuals are comparable to the gains observed in young individuals [23]. Even in this study, submaximal intensity training was set initially and progressed to 90% of the one-repetition maximum intensity. There was more significant increase in muscle mass and size after the 12 weeks of intervention with quadriceps strengthening and flexibility exercises. Maybe these changes in quadriceps muscle have shown effective improvement in the physical function of the elderly participants. In future, authors recommend examining the other lower extremity muscles strength training effect on physical function of elderly. In future, the higher velocity resistance training of selected muscles can be compared with the eccentric training exercises.

LIMITATION

The age and gender matched changes, quadriceps muscle proportion changes and muscle contractile properties, quadriceps and hamstring ratio after the intervention were not focused on in this research proposal, which can be the limitation of this study.

CONCLUSION

Quadriceps resistance exercise was shown to be more effective mode of intervention along with the flexibility exercise on physical function of elderly people. Thus, the implementation of resistance training of quadriceps will prevent the age-related sarcopenia and improve the physical function of elderly. There is a need to develop exercises that can be performed easily and utilise resisted exercises, which is relatively spared during the aging process, to improve both muscle mass and muscle strength in people with age-related muscle atrophy.

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