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Effect of Seated Leg Press Exercise on Knee Extensor Strength in Elderly

[1]K. Khoganaamat, [2]H. Sadeghi, [3]M Sahebozamani and [4]S. Nazari

[1]Candidate for sport biomechanics and Kharazmi University, Tehran, Iran
[2]Department of Physical Education and Sport Sciences, Kharazmi University of Tehran, Iran
[3]Department of Physical Education and Sport Science, Shahid Bahonar University of Kerman, Iran
[4]Department of Physical Education and Sport Science, Shahid Beheshti of Tehran, Iran

Abstract: After age 50 to 70 years, 15% of muscles strength is lost per decade. Elderly people need 90% of knee extensor strength for daily activities such as getting up from a chair, while this value is only slightly more than half in young people. The purpose of this study was to study the effect of seated leg press exercise on knee extensor strength in elderly. Twenty-four elderly men were divided in two matched groups. Resistance training group (RTG) (n=12, age 59.3±6.9 years and BMI 25.14±2.5 kg/m2) performed a set of 12 repetitions with 70% of one repetition maximum (1-RM) intensity in each session, twice a week for eight weeks. Control group (CG) (n= 12, age 63.6±5.6 years and BMI 25.48±2 kg/m2) were engaged in their daily activities in this period. Isokinetic strength of the knee extensor of both legs was determined at 60°/s with a dynamometer (Biodex system 3). The 8-week seated leg press exercise led to significant improvements in knee extension strength from pretest to posttest for both dominant and non-dominant leg in CG (respectively P= 0.002 and P= 0.003). These changes were not significant in CG (respectively P= 0.220 and P= 0.168). Performing a set of 12 repetitions with 70% of 1-RM intensity in each session, twice a week for eight weeks led to significant improvement in knee extensor strength in elderly people.

Key words: Seated Leg Press · Knee Extensor Strength · Elderly

INTRODUCTION

The world's elderly population is growing [1]. Along with the aging, structural changes occur in the human body. The most important changes are in the muscle and bone structure [2]. Loss of strength and muscle mass with aging is a well-known problem [3, 4] that is associated with reduction in functional abilities [5].

Decline in muscle strength occur further and earlier than muscle mass losses. The proximal muscles of the lower extremities are more affected by strength losses than those of the upper extremities, which in older people has been ascribed to a decreasing use of lower compared with upper limb muscles [6].

Researchers have shown that the quadriceps muscles of older people aged around 70 years have approximately 60% of the force-generating ability of young individuals aged 20–30 years [6]. While elderly people need 90% of knee extensor strength for daily activities such as getting up from a chair and this value is only slightly more than half in young people [7]. Following the loss of muscle strength, the human body is prone to hazards such as falling, which will lead to consequences such as fractures. Reduce mobility and independence in daily activities is another result of loss muscle strength in the elderly [8]. Muscle weakness associated with increased risk of falls [9], fractures and loss bone mineral density which may predispose to osteoporosis [6]. Lower extremity muscle weakness is the main risk factor for falling [10]. Reduced dorsiflexion of the foot and quadriceps muscle strength are predictors of falls and fear of falling in the elderly [11]. Rates' falling in people over 60 years is between 35 to 40% which cause 87% of fractures in these individuals. Approximately 20% of women who suffer hip fractures die and other 20% of them cannot walk without assistive devices after recovery [12]. Falls and injuries that occur as a result of falling in elderly often restrict their movement that lead to increase falling and make a vicious cycle of sedentary lifestyle-inability [13].

Corresponding Author: Khoganaamat, K., Candidate for sport biomechanics and Kharazmi University, Tehran, Iran.
Cell: +989191381448.

Deficit in quadriceps muscle strength and proprioceptive system is associated with knee osteoarthritis [14-17]. Knee joint stability requires sufficient magnitude of internal forces to counteract external forces acting at the knee. The quadriceps muscle absorbs loads and provides dynamic stability of the knee joint. Weakness of the quadriceps may alter local contact stress in a manner detrimental to articular cartilage [18]. This may lead to increase pressure on the joint that is associated with pain and knee osteoarthritis [19, 20]. Age, female sex, obesity, injury and quadriceps muscle weakness are important and strongly predictive risk factors of both radiographic and symptomatic knee osteoarthritis [21-23]. Among these, quadriceps weakness may be the most amenable to treatment for the prevention of knee osteoarthritis (OA) [24]. Daily living activities require little quadriceps strength, for example during normal walking the quadriceps is activated only briefly at the beginning and end of the gait cycle [6]. In contrast, strength training increases muscle mass, causes hypertrophy of muscles [25], improve strength and power [26, 27], increase bone mineral density [28] and postural balance [29, 30], reduce risk of falling [31], increase walking speed [32], increase stair climbing strength [33] and improve the symptoms of the knee osteoarthritis [34]. Presence of medical conditions and the baseline fitness of participants, duration and frequency of the training program, the number of sets and repetitions of each session and finally the intensity at which these repetitions are performed are the factors that make the comparison between studies problematic [6]. Thus, assuming the effects of strength training on muscle strength in the elderly, we wanted to investigate effect of seated leg press exercise on knee extensor strength in elderly.

MATERIALS AND METHODS

Subjects: Twenty four old men (61.41±6 yr) volunteered to participate in the program were divided into two homogenous resistance training group (RTG) (n=12, age 59.3±6.96 yr, weight 74.5±5.3 kg, height 172.41±6.2 cm) and control group (CG) (n=12, age 63.6±5.68 yr, weight 77.6±7 kg, height 173.4±3.7 cm) were engaged in their daily activities in this period. Inclusion criteria for subjects were age older than 55 years. Exclusion criteria were history of falls, knee pain and back surgery in the previous six months, diseases or medications affecting neuromuscular function, musculoskeletal disorders in lower extremity, cardiovascular disease, diagnosis of cerebral aneurysms or bleeding, stroke, hypertension (blood pressure = 200/110 mmHg) and history of isokinetic assessment.

Measurements: Body mass and height were measured to the nearest 0.1 kg and 0.5 cm, respectively. Knee extensor strength was assessed with an isokinetic dynamometer (Biodex system 3) at 60 º/s (it is one of the safest angular velocities for the patellofemoral joint test [35]) and a chair back angle of 85 degrees. Subjects were tested in the seated position with stabilizing straps around the waist and thigh and over the shoulder. The input shaft of the dynamometer was aligned with the axis of rotation of the subject's knee and the shin pad attachment was placed 2.5 cm proximal to the subject's lateral malleolus. The participant's lower leg segment was weighed at 30° knee flexion for gravity correction and start-stop angles were set at 90 and 30°. All subjects performed a 5-min warm-up on a stationary cycle ergometer, followed by stretching of the quadriceps muscle groups. Subjects performed three submaximal practice repetitions before testing to familiarize themselves with the protocol. Then four maximal attempts were made with a rest interval of about 60 seconds between each and the curve demonstrating the largest peak was used to determine maximal isokinetic strength. Testes started with dominant leg. Post-test measurement with the same conditions and at the same time for each subject was performed after training program.

Training Program: A 5-min warm-up on a bicycle ergometer and light stretching of lower extremity proceeded each training session. The training session consisted of one set of seated leg press consisted of 12 repetitions at 70% of the 1-RM strength value. This value was increased continually throughout the training program period to reflect increases in strength level. The control group was asked to keep their daily activity and routine life in this time.

Statistical Analysis: Kolmogorov-Smirnov test for normality and the repeated-measures ANOVA for impacts within and between groups at a significance level of p = 0/05 were used.

RESULTS

Descriptive characteristics of both groups were shown in table 1. As can be seen in Table 2, in RTG, knee extensor strength of dominant and non-dominant

Table 1: General characteristics of subjects

	Group	
	RTG (n=12)	CG (n=12)
Age, yr	59.25 ± 6.9	63.58 ± 5.6
Body weight, kg	74.5 ± 5.5	77.33 ± 6.7
Height, cm	172.42 ± 6.5	174.17 ± 4
BMI, kg/m2	25.14 ± 2.5	25.48 ± 2

RTG: Resistance Training Group

CG: Control Group

Table 2: Mean and SD of isokinetic knee extensor strength (N.m)

Group		Before	After	Pvalue
RTG (n=12)	Dominant	123.46 ± 36.48	148.56 ± 44.48	0.002*
	Non dominant	125.55 ± 45.29	149.65 ± 43.37	0.003*
CG (n=12)	Dominant	124.54 ± 39.41	135.20 ± 26.20	0.22
	Non dominant	129.32 ± 48.26	139.66 ± 41.14	0.168

*Significant level at P= 0.05

RTG: Resistance Training Group

CG: Control Group

feet significantly increased after eight weeks of exercise training (respectively P = 0.002 and P = 0.003). While this changes were not significant in control group during this period (respectively P = 0.220 and P = 0.168).

DISCUSSION

The purpose of this study was effect of seated leg press exercise on knee extensor strength in elderly. World-wide growing in elderly population requires a deeper knowledge of their musculoskeletal systems [36]. Muscle strength and force generation decline with age especially after age 60 [37, 38]. Because muscle strength is a critical component in maintaining physical function, mobility and vitality in old age, it is essential to identify factors that contribute to the loss of strength as people age [39]. Aging causes loss of strength:

- Muscle size is reduced with ageing and this quantitative loss of muscle, affects the force generation. Muscle mass loss is about 23 and 35% reported in 20 to 80 years. It has shown a 27% smaller mid-thigh CSA (Cross Section Area) of the quadriceps in older women aged between 66 and 75 years, as compared to the young, aged between 26 and 35 years [6].
- Muscle excitability and contractility decrease with age. This is strictly dependent on the integrity of both the muscle fibers and the nerve cells that control them. Number and size of motor units are reduced with ageing. Absolute values of electromyography amplitude are lower in groups of older individuals as compared to young or middle-aged subjects. The higher levels of antagonist coactivation in older individuals could be an additional explanation for the age-related decline in force production [6].
- Human tendons are responsible for the transmission of force from muscles to bones. Tendons stiffness decrease with aging [6].
- A decline in the levels of many hormones such as growth hormone, insulin like grow factor 1 (IGF-1), testosterone and oestrogen has been measured in older people [6].
- Amount of physical activity decreases with ageing but it is unclear whether this is a cause or an effect of the age-related loss of muscle function [6].

Muscular deficiency is a frequent cause of instability and unbalance [36]. Low muscle strength has been identified as a risk factor for fall [13], hip fractures and decreases in bone mineral density [40] that cause osteoporosis [6]. Leg muscle strength is positively related to speed of walking and stair climbing ability and inversely related to the incidence of hip fractures and mobility limitations [41]. One factor that could explain the impaired walking ability is weakness of the quadriceps muscles [10].

Functional and anatomical characteristics of the knee expose this joint to high mechanical stress. The knee joint is unstable and prone to injury in musculoskeletal system [36]. The frequency of these abnormalities increases with age [36]. Knee joint is the most frequently associated with disability in OA [42]. Individuals with symptomatic knee OA have weaker quadriceps, reduced knee joint proprioception and increased postural sway compared with age-and sex-matched controls [16]. Knee extensor strength and proprioception are important for control of balance and both of these as well as balance are impaired with knee OA [43].

In patients with knee OA, pain is increased by load bearing and relieved by rest. These patients minimize their painful weight-bearing activities. Therefore Quadriceps muscle weakness in these patients is expected [24]. Aerobic exercise and strength training have been found to be effective in the control of pain and maintenance of function in knee OA [44-46]. Recent study has shown that increase in knee extensor strength may reduces OA symptoms in women after 30 months of strength training [43]. Exercise has many advantages in preventative battle against the increasing number of falls and injuries in older people by improving power, strength, muscle mass [5], co-ordination, reaction time, gait and balance, all of which are risks factor for future falls [13].

Consistent with other studies, who reported positive effects of different exercises on knee extensor strength [47, 48], this study showed positive effects of seated leg press exercises on knee extensor strength in elderly people.

IT can be concluded that performing a set of 12 repetitions with 70% of 1-RM intensity in each session, twice a week for eight weeks led to significant improvement in knee extensor strength in elderly people.

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