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The Effects of Aging on Muscle Strength and Functional Ability of Healthy Iranian Males

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Abstract: loss of muscle strength as a result of normal aging is reported to impair functional ability in various communities. The purpose of this study was to examine the age at which loss of muscle strength and functional ability of aging in healthy Iranian adult males occur. A sample of 190 healthy Iranian males aged between 20 and 79 participated in this study. The subjects were divided into six age groups, each representing a decade. Maximum isometric "make" strength of bilateral quadriceps muscles was measured using a hand-grip dynamometer. Functional ability tests included stair walking, timed-up-and-go and balance tests were performed and timed by a digital stopwatch. The findings indicated that muscle strength and functional ability remained unchanged in the 20- and 30-year-old groups. At the age of 40, muscle strength and functional ability began to gradually decline. Muscle strength of males in their twenties was 41±7 kg and 38±6 kg in their right (RT) and left (LT) quadriceps respectively. A decline with aging was represented by 22±5 kg and 17±4 kg in the RT and LT quadriceps muscles respectively by the eighth decade of life. One-way ANOVA test showed that muscle strength and functional ability differed ($P<0.01$) among decades, except between the second and third decades ($P<0.32$). Age, muscle strength and functional ability displayed a significant relationship ($P<0.001$). Loss of muscle strength and functional ability seemed to begin in the fourth decade of life. The changes in muscle strength and functional ability had a significant relationship with aging.

Key words: Muscle Strength % Functional Ability % Aging

INTRODUCTION

Advantage adult age is associated with profound change in body composition [1-5]. One of the most prominent of this change is sarcopenia, Sarcopenia is a life - long process that likely begins in young adulthood this loss of skeletal muscle mass is also associated with increasing body fatness, decreased basal metabolic rate and daily energy needs, loss of bone mass, reduction strength and functional status. Nutrient requirements also may change with age [1, 2, 4, 5].

Loss of muscle strength as a result of normal aging is reported to impair functional ability in various communities [1-3]. There is not a similar pattern for the age at which the loss of muscle strength and functional ability begins in different communities [1, 3, 4]. Such a difference necessitates the establishment of a database on muscle strength and functional ability loss for any given population. This information can provide clinicians with accurate guidelines on the normal changes in muscle strength and functional ability throughout aging. This study aims to establish a preliminary baseline for the effects of aging on muscle strength and functional ability of Iranian males.

MATERIALS AND METHODS

190 Iranian males aged between 20 and 79 volunteered to participate in this study. The subjects were healthy and claimed no known musculoskeletal, neuromuscular or cardiovascular pathology affecting their functional ability. None were engaged in physical activity for more than two sessions per week. They were aware of the purpose of the tests. The characteristics of subjects grouped by decade are shown in Table 1.

Quadriceps Strength Testing: Isometric quadriceps strength was measured bilaterally using a Nicholas hand-grip dynamometer. Subjects sat upright in a test

Table 1: Characteristics of subjects grouped by decade

Decade	Age (yr)	Weight (kg)	Height (cm)
20s (n=44)	24±4	64±7	169±8
30s (n=37)	32±6	69±10	171±4
40s (n=33)	47±8	74±8	169±10
50s (n=32)	59±4	78±11	171±8
60s (n=23)	64±9	75±7	174±6
70s (n=21	72±5	68±5	172±11

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chair with hips and knees flexed at approximately 90 degrees. A restraining belt was strapped across the waist to minimize unwanted hip, pelvic girdle and lower trunk movements. The subjects' hands were positioned across their chests. The hand-grip dynamometer was then fixed just proximal to the malleolus. The subjects were asked to build the force to maximum over a 2-second period and to maintain the maximum effort for approximately 5 seconds. The subjects were then requested to stop. This procedure has been shown to be reliable and adequate to measure the maximum isometric quadriceps strength. The peak force of three readings for each leg was recorded to characterize the strength of the quadriceps.

Functional Ability Testing: Functional ability tests, which included stair walking, timed up-and-go and balance, were performed and timed in second (sec.) using a digital stopwatch. These are quick and practical tests of basic mobility that form part of a functional ability in different age groups.

Stair Walking Test: Each subject stood in front of a small wooden staircase which consisted of four steps of 25 cm up and four steps of 20 cm down. They were instructed to follow the command "Go" to walk up and down the staircase at a comfortable pace. They were not allowed to stop or use the handrail as a support. The task was timed.

Timed Up-and-Go Test: The subjects were seated in an armchair and instructed to follow the command "Go" to rise from the chair without using the arms for support, walk five meters along a level corridor, turn, return to the chair and sit down at their own comfortable speed. The task was timed.

Balance Test: The subjects were asked to stand on their preferred leg with open eyes. The task was timed from the moment the leg was lifted up the floor until the balance was lost or the foot was placed on the floor again.

Data Analyses: One-way ANOVA was used to determine the difference among the age groups. Bonferroni post-hoc test was used to determine which group was different from the other groups, with "=0.05. Multiple regression analysis was also used to determine the nature and degree of the relationship between muscle strength, functional ability tests and age. The SPSS software was used to analyze the data.

RESULTS

A summary of the quadriceps strength and functional ability measurements for each age group is presented in Table 2. The isometric quadriceps strength in the second decade was 45±7 kg and 43±6 kg in the right (RT) and left (LT) quadriceps respectively. A gradual decline in the quadriceps strength continued to the seventh decade. One-way analysis of variance test showed no significant difference between the muscle strength in the second and third decade ($P<0.18$). In contrast, a significant difference was found in muscle strength among the age groups ($P<0.001$).

The time required for subjects in their seventh decade to complete the stair walking test was thrice more than (15±7 sec.) that required for subjects in their second decade of life (6±2 sec.). It also took thrice more than the time (24±4 sec.) required for the subjects in their seventh decade to complete the timed up-and-go test when compared to the subjects in their second decade (10±3 sec). These differences among the age groups is significant excluding ($P<0.01$).

The difference between the second and third decade was not significant ($P<0.32$).

In the balance test, the subjects in the second decade balanced themselves for 142±24 seconds while in the seventh decade they maintained their balance for 22±4 seconds. These differences among the age groups were significant ($P<0.01$).

Regression analysis showed that age is significantly ($P<0.001$) associated with muscle strength (r^2=0.54 to 0.62), stair walking test (r^2=0.77),

Table 2: Mean±SD of muscle strength and functional ability tests of different age groups

	Muscle strength (N)				
Decade (yr)	RT	LT	Stair walking (sec.)	Timed up-and-go	Balance
20s	45±7	43±6	6±2	10±3	142±19
30s	43±5	42±4	6±2	10±4	137±22
40s	34±7	32±5	8±3	13±5	101±15
50s	30±6	29±6	10±4	17±3	74±17
60s	24±7	22±8	13±5	20±6	46±14
70s	22±5	20±5	15±7	24±4	22±40

Table 3: Regression analysis between age, muscle strength and functional ability

	Age		Muscle strength			
			Right		Left	
Decade (yr)	R	R^2	R	R^2	R	R^2
Muscle strength						
Right	0.79	0.62	-	-	-	-
Left	0.74	0.54	-	-	-	-
Stair walking	0.88	0.77	0.58	0.33	0.55	0.31
Timed up-and-go	0.80	0.64	0.49	0.24	0.45	0.20
Balance	0.88	0.77	0.77	0.79	0.87	0.76

P<0.001

timed up-and-go test (r^2=0.64) and balance test (r^2=0.77) (Table 3). Muscle strength also showed a significant association (P<0.001) with stair walking test (r^2=0.31 to 0.33), timed up-and-go test (r^2=0.20 to 0.24) and balance test (r^2=0.76 to 0.79).

DISCUSSION AND CONCLUSION

In this study, the isometric quadriceps strength and functional ability remained fairly stable throughout the second and third decade of life. A gradual significant loss started in the fourth decade in these groups. It is not clear if the reduction in muscle strength and functional ability during the fourth decade was due to age-related changes, a sedentary lifestyle or a combination of both. However, the significant correlation was found between age and muscle strength and functional ability among the subjects in their fourth decade. Researchers may be encouraged by this study to review the relationship between the muscle morphology and biochemistry, sensory input and the impact of lifestyle on muscle strength and physical performance of people in their forties. Whatever the causes of declining muscle strength and functional ability, the fourth decade is considered a turning point for muscle strength and physical performance.

The gradual declines in muscle strength and functional ability as a result of aging have also been reported in various communities [5-7]. This decline is related to normal aging processes [3, 6, 8], lifestyle and vocational, behavioral, cultural and physical activities [9, 10]. However, the degree and pattern of decline differ from one community to another. These studies cannot be compared with our study because of differences in equipment and procedures used in measuring muscle strength and/or functional ability. Also, specific comparisons are difficult because of the inconsistent grouping of the subjects in various studies.

The results of this study demonstrate a relationship between age, lower extremity muscle strength and functional ability. It has also been observed that an increase in gait speed is associated with a higher level of muscle activity [4, 7, 8, 11]. Thus, muscle strength generation is essential to ambulation.

The speed of the tested functional activity is important because of its implications for community ambulation [11-15].

In this study, the loss of strength in the isometric quadriceps began during the fourth decade of life. In another study, isometric quadriceps strength began to decline in the fifth decade [16, 17]. The awareness of losing muscle strength and endurance was also reported to occur at about the age of 50 [18]. These variations may be due to different anthropometric characteristics and habitual level of functional activity of the participants in various studies [4, 15, 18]. Differences in equipments and procedures used to measure muscle strength may also contribute to the variations. Body weight and height have been shown to correlate with quadriceps strength [4, 20]. Habitual level of physical activity and the degree of physical effort have been reported to affect muscle strength [9, 10].

This study confines the extreme importance of quadriceps muscle strength for activities of daily living [2, 6, 19]. A regular quadriceps muscle strengthening program may be helpful in maintaining functional activity involving the lower extremity [20].

Muscle strength plays an integral role in the structure and function of joints and bone mass. The degree to which muscle strength loss in the fourth decade of life affects the structure and function of joints and bone mass in the elderly, is a question that needs to be answered [21, 22].

Health care expenditures increase when subjects begin to lose their functional ability [23]. This could imply that people aged 40 and older may spend more money on health care than the younger population [24, 25]. Consequently, to lower health care expenditure for people aged 40 and over, it is necessary to find a proper solution to reduce the reported loss in functional ability. Regular physical exercise such as balancing, strength training, low-impact aerobic exercises, body flexibility exercises, functional exercises and health promotion in the workplace have been documented to improve functional ability and self-reported health status in various communities [20, 21]. These exercises and health promotion in the workplace could also be used for Iranians to reduce the declining rate of functional ability [24, 26].

The reduction in balance ability between the fourth and the eighth decades of life could indicate an increased risk of falling. Falls are the most important reason for the elderly who are admitted to the hospital and apprehension about falling is a source of distress in 25% to 50% of community-dwelling elderly people [14]. Quadriceps weakness has been associated with an increased incidence of falls in elderly subjects. An intervention program of muscle strength and balance exercise has been suggested to prevent falls [17].

In summary, isometric quadriceps strength is able to determine the level of physical activities that can be performed during the aging process. Subjects in their fourth decade of life and above are at an increased risk for various physical and functional limitations. The figures produced in this study can provide therapists with a guide to normal isometric quadriceps strength level and functional ability of a healthy and active population.

REFERENCES

1. Vandervoort, AA., 1992. Effects of aging on human neuromuscular function: implications for exercise. Can J. Sport Sic., 17: 178-84.
2. Bohannon, R., 1997. Comfortable and maximum walking speed of adults aged 20-79 Years: reference values and determinants. Age Ageing, 26: 15-9.
3. Larsson, L., G. Grimsby and J. Carlson, 1979. Muscle strength and speed of Movement in relation to age and Muscle morphology. J. Apple. Physiol., 46: 451-6.
4. Bohannon, R., 1997. Reference values for extremity muscle strength obtained by hand-held dynamometry from adults aged 20 to 79 years. Arch Phys. Med. Rehab., 78: 26-32.
5. Marks, R., 1992. The effect of ageing and strength training on skeletal muscle. Aust. Physiother, 38: 9-19.
6. Hurley, M., J. Rees and D.Wenham, 1998. Quadriceps function, propriocepti Acuity and functional performance in healthy young, middle-aged and elderly subjects. Age Ageing., 27: 55-62.
7. Brown, M., D. Sinacore and H. Host, 1995. The relationship of strength to function in the older adult. J. Gerontol., 50: 55-9.
8. Wilmore, J., 1991. The aging of bone and muscle. Cline Sport. med., 10: 231-44.
9. Cooper, C., D.J.P. Barker and C. Wick ham, 1988. Physical activity, muscle strength and calcium intake in fracture of the proximal femur in Britain. BMJ, 297: 1443-8.
10. Rings berg, K., 1993. Muscle strength differences in urban and rural population in Sweden. Arch. Phys. Med. Rehab., 74: 1315-8.
11. Nelson, P., S. Hughes, S. Virjee, H. Beresford, C. Murray and E. Watson, *et al*. 1991. Walking speed as a measure of disability. Care Elderly, 3: 125-6.
12. Robinett, C. and M. Vondran, 1988. Functional ambulation velocity and distance Requirements in rural and urban communities. Phys. Ther., 68: 1371-3.
13. Cunningham, D., D. Paterson, J. Human and P. Reconnoiter, 1993. Determinants of Independence in the elderly. Can J. Apple. Physiol., 18: 243-54.
14. Tinetti, M., M. Speech and S. Ginter, 1988. Risk factors for falls among elderly Persons living in the community. N Engle J. Med., 319: 1701-7.
15. Andrews, A.W., M.W. Thomas and R.W. Bohannon, 1996. Normative values for Isometric muscle force measurements obtained with hand-held Dynamometers. Phys. Ther., 76: 248-59.
16. Ivrson, B.D., M.R. Grossman, S.A. Shaddean and M.E. Turner, 1990. Balance Performance, force production and activity level in non-institutionalized Men 60-90 years of age.Phys. Ther., 70: 348-55.
17. Skelton, D.A. and A.W. McLaughlin, 1996. Training functional ability in old age Physiotherapy, 82: 159-67.
18. Tseng, B., D. Marsh, M. Hamilton and F. Booth, 1995. Strength and aerobic training Attenuate muscle wasting and improve resistance to the development o Disability with aging. J. Gerontol., 50: 113-9.
19. Miyashita, M., H. Matsui and M. Miura, 1971. The relation between electrical Activity in muscle and speed of walking and running. Med. Sport., 6: 192-6.
20. Nordstrom, P., K. Thrones, G. Nordstrom, E. Bergstrom and R. Lorenzo, 1995. Bone mass, muscle strength and different body constitutional parameters In adolescent boys with a low or moderate exercise level. Bone, 17: 351-6.
21. Wiles, C. and Y. Karni, 1983. The measurement of muscle strength in patients with peripheral neuromuscular disorders. J. Neurol Neurosurg Psychiatry, 46: 1006-13.

22. Cochrane, T., J. Munro, R. Davey and J. Nicholl, 1998. Exercise, physical function and health Perceptions of older People. Physiotherapy, 84: 598-602.
23. Lung, M., H. Hartselle and A. Vandervoort, 1996. Effects of ageing on joint stiffness: implications for exercise. Physiother Can, 48: 96-106.
24. Snow-Harter, C., M. Bouxsein, B. Lewis, S. Charette, P. Weinstein and R. Marcus, 1990. Muscle strength as a Predictor of bone mineral density in young Women. J. Bone Miner Res., 5: 589-95.
25. Reynolds, P., 1991. Characteristics of ageing skeletal muscle. Physiother Theory Pract, 7: 157-62.