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>
<thead>
<tr>
<th>Decade</th>
<th>Age (yr)</th>
<th>Weight (kg)</th>
<th>Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20s (n=44)</td>
<td>22±4</td>
<td>64±7</td>
<td>169±8</td>
</tr>
<tr>
<td>30s (n=37)</td>
<td>32±6</td>
<td>69±10</td>
<td>171±4</td>
</tr>
<tr>
<td>40s (n=33)</td>
<td>47±8</td>
<td>74±8</td>
<td>169±10</td>
</tr>
<tr>
<td>50s (n=32)</td>
<td>59±4</td>
<td>78±11</td>
<td>171±8</td>
</tr>
<tr>
<td>60s (n=23)</td>
<td>64±9</td>
<td>75±7</td>
<td>174±6</td>
</tr>
<tr>
<td>70s (n=21)</td>
<td>72±5</td>
<td>68±5</td>
<td>172±11</td>
</tr>
</tbody>
</table>

Table 1: Characteristics of subjects grouped by decade

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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.

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 “$$\alpha$$”=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

<table>
<thead>
<tr>
<th>Decade (yr)</th>
<th>RT</th>
<th>RT</th>
<th>Stair walking (sec.)</th>
<th>Timed up-and-go</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>20s</td>
<td>45±7</td>
<td>43±6</td>
<td>6±2</td>
<td>10±3</td>
<td>142±19</td>
</tr>
<tr>
<td>30s</td>
<td>43±5</td>
<td>42±4</td>
<td>8±3</td>
<td>13±5</td>
<td>137±22</td>
</tr>
<tr>
<td>40s</td>
<td>34±7</td>
<td>32±5</td>
<td>10±4</td>
<td>17±3</td>
<td>74±17</td>
</tr>
<tr>
<td>50s</td>
<td>30±6</td>
<td>29±6</td>
<td>13±5</td>
<td>20±6</td>
<td>46±14</td>
</tr>
<tr>
<td>60s</td>
<td>24±7</td>
<td>22±8</td>
<td>15±7</td>
<td>24±4</td>
<td>22±40</td>
</tr>
<tr>
<td>70s</td>
<td>22±5</td>
<td>20±5</td>
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</tbody>
</table>
Table 3: Regression analysis between age, muscle strength and functional ability

<table>
<thead>
<tr>
<th>Decade (yr)</th>
<th>Age</th>
<th>Right</th>
<th>R</th>
<th>R²</th>
<th>Left</th>
<th>R</th>
<th>R²</th>
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<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Muscle strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>0.79</td>
<td>0.62</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Left</td>
<td>0.74</td>
<td>0.54</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stair walking</td>
<td>0.88</td>
<td>0.77</td>
<td>0.58</td>
<td>0.33</td>
<td>0.55</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>Timed up-and-go</td>
<td>0.80</td>
<td>0.64</td>
<td>0.49</td>
<td>0.24</td>
<td>0.45</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>Balance</td>
<td>0.88</td>
<td>0.77</td>
<td>0.77</td>
<td>0.79</td>
<td>0.87</td>
<td>0.76</td>
<td></td>
</tr>
</tbody>
</table>

P<0.001

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


