Sarcopenia: Mini-Review and Results of the Ukrainian Study

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Abstract

Our mini-review presents the data on epidemiology, pathogenesis, diagnostics and management of sarcopenia. The Ukrainian study is aimed at evaluating the body composition and frequency of pre-sarcopenia occurring in women of different age. From September, 2005 to January 2012, the Ukrainian Scientific-Medical Centre for the Problems of Osteoporosis (Kyiv, Ukraine) has examined 8637 women aged 20-89 years. Lean and fat masses were measured by DXA using a densitometer Prodigy, GE. Appendicular skeletal mass was measured at all the four limbs with DXA. We’ve also calculated the appendicular skeletal mass index (ASMI) according to the formula: ASM/height (kg/m²). For calculation of frequency of pre-sarcopenia occurring in the women aged 65 years and older, we used the ASMI cutoff for sarcopenia proposed by Baumgartner R. (5.45 kg/m² for women). We have found a significant influence of age on the variability of lean and fat masses in women. The maximal parameters of fat and lean masses were observed in those aged 50-59 years. The median frequency of pre-sarcopenia ascertained by DXA is 7%. The highest frequency was determined in the age-group of 85-89 years (10.4%).

INTRODUCTION

Hippocrates was the first to describe the muscles changing with age.

Until recently, sarcopenia hasn’t been attracting enough attention from gerontologists and other specialists in the medical field. The role of skeletal muscles, their mass and strength in maintaining health and prolonging life remains undervalued, but presently the attitude of scientists to the problem of sarcopenia is changing.

In 1989, Irwin Rosenberg proposed the term ‘sarcopenia’ (Greek ‘sarx’ or flesh + ‘penia’ or loss) to describe this age-related decrease of muscle mass. According to Baumgartner, sarcopenia was independently associated with falls, and, in both sexes, with physical disability even when adjusted for age, obesity, and comorbidities.

According to the data of the U.S. Center for Disease Control and Prevention (CDC), sarcopenia recognized as one of the five main risk factors for morbidity and mortality in persons older than 65 years [1]. Elderly subjects within the age range of 70-80 years in the lowest quartile of muscle density were found to have a 51% higher risk of hospitalizations than those in the highest quartile [16], which might explain the sarcopenia-associated increased risk of morbidity and mortality [2-6].

Epidemiology

Sarcopenia affects both sexes indiscriminately, and is observed in both men and women. The prevalence of sarcopenia in the United States and parts of Europe has been reported to be 5-13% in the people aged 60–70 years and 11%-50% in those older than 80 years [7]. The NMEHS study showed that in a New Mexico population 15% of males and 24% of females aged 65-70 years were sarcopenic. This rose to >50% in both sexes among the over 80 years. The similarly measured representatives of the Caucasian New England population made an even more dramatic impression: 53% of men and 31% of women aged over 80 years were sarcopenic. A much lower prevalence of sarcopenia was seen amongst the Danish women with sarcopenia diagnosed in 12% of >70-year olds and in Taiwan, with 26% of men and 19% of women over 80 years sarcopenic [8,9]. Data from the Asian countries report the prevalence of sarcopenia to be between 8% and 22% for females and between 6% and 23% for males [7,10,11].

Mechanisms of sarcopenia

There are many reasons contributing to the loss of muscle mass. The loss of muscle mass in sarcopenic persons has been traditionally described as the primary (physiological) and secondary (pathological). The primary sarcopenia is believed to develop with age if the secondary factors influencing the skeletal
muscles are absent. There are several mechanisms that may be involved in the onset and progression of primary sarcopenia (Figure 1). Secondary form of sarcopenia is a consequence of exposure to one or more conditions/factors which effect on muscle (sarcopenia associated with reduced physical activity, nutrition, concomitant diseases, etc.) [12-17].

Diagnosis of sarcopenia

To estimate the ration of fat and fat-free mass, computed tomography (CT), magnetic resonance imaging (MRI) and dual-energy X-ray absorptiometry (DXA) are concurrently used. CT and MRI are considered the “gold” standard for diagnosis of the physiological and pathological conditions of soft tissues and often used in clinical studies. In the routine practice, the evaluation of soft tissues using CT and MRI is limited due to the high cost of the survey and high level of ionizing radiation. In this case, the DXA comes in handy as a preferred alternative for the determination of fat and fat-free tissue. Measured with DEXA, the technical precision of the obtained ratio of fat mass and “appendicular” skeletal muscle mass is ±1.5% and ±3.0%, respectively. DXA radiation exposure is minimal (0.037 mrem – GE Lunar Prodigy, 0.01 mGy – Hologic Discovery) compared with other techniques. The difference in the precision of the data obtained by means of DXA and CT or MRI is less than 5% [14, 18-24].

No definition of sarcopenia has received any universal acceptance. In 1998, Richard Baumgartner suggested a definition based on a measure of relative muscle mass obtained by dividing absolute muscle mass, evaluated by dual-energy X-ray absorptiometry (DXA), by height squared; which is the one widely used even now. Lean mass of total body includes parenchymal organs and the predominant amount of fat mass; hereby it is impossible to separate the subcutaneous and visceral adipose tissue. To diagnose a sarcopenia, the muscle mass of the four limbs is assessed by means of DXA (appendicular skeletal muscle mass or ASM) and skeletal muscle mass index (SMI) is determined according to the formula – ASM/height² (kg/m²). A SMI two standard deviations below the mean SMI of young male and female reference groups is defined as the gender-specific cut point for sarcopenia. The developed cut points are 7.26 kg/m² for men and 5.45 kg/m² for women [1].

The European Working Group on Sarcopenia in Older People (EWGSOP), created in 2009, developed a practical clinical definition and consensus diagnostic criteria for the age-related sarcopenia. Regarding this consensus, sarcopenia is a syndrome characterized by a progressive and generalized loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, poor quality of life and death [12]. The EWGSOP considers both the low muscle mass and the low muscle function (strength or performance) to be the pre-requisites for the diagnosis of sarcopenia (Table 1). It means that for sarcopenia to be diagnosed, the proper record of criterion 1 plus either criterion 2 or criterion 3 must be made.

A wide range of methods can be used to assess muscle mass, strength and performance (Table 2) [12]. Application of these technics in clinical practice and in trials depends on their cost, availability and ease of use.

Management of sarcopenia

Exercise and physical activity: The recommended therapy in case of a diagnosed sarcopenia might follow two courses: exercise and physical activity. Traditional aerobic exercises

![Figure 1] Mechanisms of sarcopenia.

![Figure 2] Fat (A) and lean (B) masses in women depending on age.
Table 1: EWGSOP conceptual stages of sarcopenia (EWGSOP, 2009).

<table>
<thead>
<tr>
<th>Stage</th>
<th>Muscle mass</th>
<th>Muscle strength</th>
<th>Performance</th>
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<tr>
<td>Presarcopenia</td>
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<tr>
<td>Sarcopenia</td>
<td>↓</td>
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<td>Severe sarcopenia</td>
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Table 2: Measurements of muscle mass, strength, and function in research and practice (EWGSOP, 2009).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Research</th>
<th>Clinical practice</th>
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<tr>
<td>Muscle mass</td>
<td>• Computed tomography (CT)</td>
<td>• Bioimpedance analysis</td>
</tr>
<tr>
<td></td>
<td>• Magnetic resonance imaging (MRI)</td>
<td>• Dual energy X-ray absorptiometry</td>
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<td></td>
<td>• Dual energy X-ray absorptiometry</td>
<td>• Anthropometry</td>
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<td></td>
<td>• Bioimpedance analysis</td>
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<td></td>
<td>• Total or partial body potassium per fat-free soft tissue</td>
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<tr>
<td>Muscle strength</td>
<td>• Handgrip strength</td>
<td>• Handgrip strength</td>
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<td></td>
<td>• Knee flexion/extension</td>
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<td>• Peak expiratory flow</td>
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<td>Physical performance</td>
<td>• Short Physical Performance</td>
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<td></td>
<td>• Battery</td>
<td>• Battery</td>
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<tr>
<td></td>
<td>• Usual gait speed</td>
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<td></td>
<td>• Timed get-up-and-go test</td>
<td>• Get-up-and-go test</td>
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<td>• Stair climb power test</td>
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are beneficial for cardiovascular and respiratory systems, and have a positive impact on the ratio of fat and lean body mass. Muscle-strengthening anaerobic exercise has been reported to have a greater effect on the musculoskeletal system and to prevent osteoporosis and sarcopenia. 10–12 weeks of training with sessions lasting 30 minutes, 2 times a week, resulted in a significant increase of muscle strength in the older men and women. Effectiveness of physical activity exceeds the results of other types of treatment of sarcopenia, applied without combination with exercise (different versions of hormone replacement therapy, nutrition correction, etc.) [8,25–27].

Nutrition: It is known that the amount of food eaten by people in their older age decreases leading to the development of an age-related anorexia, influenced by visceral, hormonal, neurological, pharmacological and psychosocial factors. Sayhoun N. (1992) observed that 50% of elderly people consume less than 1.0 of high quality protein per 1 kg of weight per day. Results of the study by Roubenoff R., Hughes V. (2000) showed that 30% of the elderly people use less than 0.8 g/kg/day of protein, 15% - less than 0.6 g/kg/day. Consuming ≤ 0.45 g/kg/day of protein would lead to a progressive and rapid loss of lean mass and functional status of skeletal muscle. Solerte S. (2008) found that an additional dose of protein at 0.25 g/kg/day caused a significant increase of lean mass in patients with sarcopenia. The optimal amount of consumed protein for the elderly people is 1.2-1.5 g/kg/day, for the people of middle age – 0.8 g/kg/day. Preliminary results of a recently published randomized study have shown that the optimal amount of a high-quality protein is 25-30 g per meal, as higher protein content does not cause stimulation of protein synthesis in a muscle tissue [8,9,28].

Pharmacotherapy: Results of numerous studies confirmed an increased risk of sarcopenia (2 times) when associated with a vitamin D severe deficiency (less than 25 nmol/l). Vitamin D supplementation for the elderly people prevents the development of sarcopenia, physical disability and the risk of falls. Further large randomized controlled trials are needed to assess the safety profile of vitamin D supplementation and to draw recommendations for the management of sarcopenic people in clinical practice [8,12,29,30].

Epidemiological studies have confirmed the association between the decline of testosterone level with age and decreased muscle strength and function. Reduction of estrogen level in women in the postmenopausal period also has a significant effect on the muscle strength. By converting testosterone estrogen has an anabolic effect on muscle protein synthesis. In addition, both of these sex hormones inhibit the production of pro-inflammatory cytokines with catabolic effects on the muscles. However, using estrogen and testosterone-based drugs did not have any significant effect on the female muscle strength. When assigning a testosterone replacement therapy for men mixed results were obtained depending on the age of examined persons. Several studies have shown a positive role of testosterone therapy on lean mass and muscle strength in the hypogonadal young men. Muscle strength increased from 20 to 60%, which was slightly lower compared with the efficiency of power exercise. Anabolic effect of testosterone therapy in the older hypogonadal men was less pronounced, many studies have noted minimal changes of body composition and muscle strength did not increase. Several studies have demonstrated an increase of muscle strength from 10 to 25%, but these studies were not placebo-controlled. Application of the small doses of testosterone therapy in the older men may increase the risk of developing prostate cancer [8,19].

Growth hormone (GH) has an indirect anabolic effect on muscle through IGF-1 which is synthesized in the liver for systemic release. IGF-1 helps improve muscle function by increasing production of muscle satellite cells as well as stimulating production of muscle contractile proteins. Typically, the level of GH and IGF-1 levels declines with age. The amplitude and frequency of pulsatile GH release is also significantly reduced. Therefore, there is a hypothesis that the appointment
of GH therapy in the elderly can prevent the loss of muscle. Nevertheless, the majority of studies have shown that this therapy is not effective when status of muscle mass and function are concerned. Some studies have shown an increase in muscle mass but no improvement in muscle strength, whereas others have shown an increase in both muscle mass and strength after administration of GH therapy in older people. Boonen et al. noted that the appointment of IGF in older women who have faced a femoral neck fracture leads to an increase of muscle strength. However, today, the evidence for the use of GH in older people for management of sarcopenia is weak. Moreover, the majority of trials involving GH replacement therapy in older people have reported a high incidence of side effects, including increased fluid retention, gynecomastia, orthostatic hypotension, and carpal tunnel syndrome [3].

The recently recognized therapy for sarcopenia is administration of myostatin inhibitors and selective androgen receptor modulators etc. [3,12].

SARCOPENIA AND PARTICULARITIES OF BODY COMPOSITION IN UKRAINIAN WOMEN

The aim of this study

Is to evaluate the body composition and frequency of presarcopenia in women of different age.

Materials and methods

From September, 2005 to January, 2012, the Ukrainian Scientific-Medical centre for the Problems of Osteoporosis (Kyiv, Ukraine) has examined 8637 women aged 20-89 years (mean age – 56.7±0.14 yrs; mean height – 1.62±0.07 m; mean weight – 73.5±0.16 kg). The patients were divided into groups depending on age.

Lean and fat masses were measured by DXA using a densitometer Prodigy, GE. Appendicular skeletal mass (ASM) was measured at all the four limbs with DXA. We’ve also calculated the appendicular skeletal mass index (ASMI) according to the formula: ASM/height (kg/m²). For calculation of frequency of presarcopenia occurring in women aged 65 years and older we used the SMI cutoff for sarcopenia, proposed by Baumgartner R. (5.45 kg/m² for women).

Baseline variables were analyzed for difference using the independent sample T-test and Chi-square test. An one-way ANOVA test was used to compare the differences among the multiple groups. Significance was set at p<0.05. The study results are presented in the following manner: M±SD. “Statistika 6.0” © StatSoft, Inc. was used for data processing purposes.

Study results

Demographic and anthropometric characteristics of examined women are presented on We have found the significant influence of age on variability of lean and fat masses in women (F=83.19, p<0.0001; F=29.15; p<0.0001; accordingly). The maximal parameters of fat and lean masses were observed in women aged 50-59 years. Histograms of the distribution of fat and lean masses are presented in (Figure 3).

Osteoporosis frequency was found to increase with age, in conformity with the official positions of the International Society for Clinical Densitometry for 2013 [22]. Systemic osteoporosis was observed in 13% of women aged 50-59 years, 22% – 60-69 years, 29% – 70-79 years, 32% – 80-89 years.

The average frequency of presarcopenia determined by DXA was 7%. The highest frequency was found in the age-group of 85-89 years (10.4%) (Table 4).

So, the findings as for the frequency of presarcopenia in Ukraine match the mean parameters of frequency in the European and Asian countries [3,17,32].

CONCLUSION

Sarcopenia is a geriatric syndrome that is often observed in the elderly and senile patients, reduces their physical abilities, affects the quality of life, and increases the incidence of falls and consequently the risk of osteoporotic fractures. In this regard,
epidemiological studies on the prevalence and risk factors of sarcopenia in the older age groups, development of diagnostic methods, prevention and treatment of this condition are needed.

REFERENCES


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