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Mini Review

To Feed and Move the Muscles are
Crucial for Healthy Ageing

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Abstract

Ageing is associated with reduced margins and impairments in several physiological systems including increase in body fat and a decline in lean mass called sarcopenia and limiting physical abilities. Disease Related Malnutrition (DRM) becomes prevalent due to increased risk to develop chronic disease by age. To prevent and reduce the loss of muscle mass and function physical activity and nutrition are of importance. The evidence for a combination effect is convincing. Except adequate energy intake protein and vitamin D are of specific importance to maintain muscle mass. Some amino acids seem of key importance. A major cause of sarcopenia is inactivity and anabolic resistance. Physical exercise, mainly resistance training has been shown to be of significant importance for muscle protein synthesis. Adequate muscular function is a prerequisite for independence and quality of life. It is urgent to learn more about how to prevent and treat loss of muscle mass and function in ageing.

Introduction

Ageing is associated with reduced margins and impairments in a number of vital physiological systems in the body. In later years the term frailty has become frequently used to describe this progressive change characterized by a continuous reduction of homeostatic capacity, in different organ systems, leading to a consequent increase in morbidity and mortality [1,2]. One of these changes is the transformation in body composition with an increase in body fat and a corresponding decline in lean mass predominantly muscle mass with subsequent decline in function and strength with increasing age [2-4]. This phenomenon is called sarcopenia [2] and may over time limit the ability to cope with the activities of daily living, reducing independence and causing an increased need for help and assistance in older adults. It has been estimated to cost \$18.5 billion (\$10.8 billion in men, \$7.7 billion in women) in direct healthcare costs in the United States in the year 2000 [5]. The etiology is multifactorial including disturbed balance between muscle protein synthesis and degradation shifting towards net catabolism [6]. On top of that, Disease Related Malnutrition (DRM) becomes prevalent in higher age groups due to increased risk to develop chronic disease with increasing age [7]. DRM is characterized by inflammation that cause decreased appetite and catabolism meaning degradation of muscle mass. It should be stated that all involuntary weight loss in old age strikes muscle mass.

To prevent and reduce the loss of muscle mass and function there are two lifestyle factors that are possible to influence - physical activity and nutrition [2,6]. The evidence for a combination effect of these two cornerstones in healthy aging are convincing [8,9].

Nutrition

Except adequate energy intake to maintain body weight two nutrients are especially important during aging to maintain muscle mass. Those are protein and vitamin D. Visceral turns over seems to increase by age [6,10] meaning that higher amounts of protein per kilo body weight is needed to provide muscle tissue with enough protein to maintain adequate muscle mass synthesis. Some amino acids seem more central than others in this process. Leucine, an essential and branched amino acid, has been shown especially efficient to stimulate muscle protein synthesis. It has been identified as the main nutritional signal responsible for stimulating postprandial muscle protein synthesis [10,11]. It has also been shown that dietary protein intake is associated with significant changes in lean body mass in older, community dwelling adults [12]. The associations were most apparent among subjects who were in positive or negative energy balance. Further, studies have shown that timing is important. The body use protein more efficiently when it is consumed close in time before or after physical activity [6] and it seems like the "dose" need to be 25-30 gram per meal to reach optimal effect [13].

A micro nutrient of great interest is vitamin D. It is a prohormone that will be converted in two steps first in the liver and then in the kidney to end up in its active form 1,25 OHD which has pleiotropic functions in the body with vital roles in several physiological systems [14,15]. One important target tissue is the muscle. It has been shown that lower 25-OHD and higher PTH levels increase the risk of sarcopenia in older adults [16]. Further on deficiency has been reported to affect

predominantly the weight-bearing muscles of the lower limb, which are necessary for postural balance and walking [17], and a significant correlation between serum 25-OHD status and the occurrence of falls has been shown [18-20].

Positive effects of supplementation have been shown as well grip strength, proximal lower limb strength has hip muscle strength [15]. The mechanistic effect is yet not clear, but in animal models vitamin D pathways regulates muscle development and in cultured muscle cells vitamin D signaling alters various molecular pathways [21]. A great proportion of older adults show low levels of this vital vitamin [14] depending on low intakes, low level of sun exposure and diminished capacity to convert UV-B light into hydroxyl cholecalciferol. Further on the formation of 125-OHD may be restricted by impairment of renal function.

Physical exercise

However, good nutrition could not alone maintain muscle mass and function. Physical exercise mainly resistant training has been shown of significant importance [8,9]. The anabolic response to dietary protein or amino acids and insulin is limited but a combination effect of the two lifestyle factors physical activity and nutrition stimulates muscle protein synthesis. Both endurance- and resistance exercises are recommended at individualized levels that are safe and tolerated.

A major cause to the development of sarcopenia is inactivity followed by anabolic resistance [22]. Immobilization induces resistance of muscle to anabolic stimulation [23]. Reduction of step count for two weeks cause anabolic resistance shown by decreased response of muscle protein synthesis to protein intake, decreased insulin sensitivity, and lowered leg muscle mass in older adults [24]. However, aging muscle does respond to exercise, especially resistance exercise. This has been shown also in very old people (more than 90 years) [25] and a meta-analysis on progressive resistance training in older adults has shown significant benefits for improved physical function [26]. Increased insulin sensitivity, improved glucose utilization [27] and [28] enhanced myofibrillar protein synthesis [29] may be among the mechanisms behind this effect of resistance exercise [2] but it has also been suggested that exercise-induced improvement in protein synthesis may be due to nutrient-stimulated vasodilation and nutrient delivery to muscle rather than to improved insulin signaling [30].

Conclusion

Function muscles are a prerequisite for independence and thereby quality of life. Sarcopenia leads to immobility need of help in daily life and loss of independence and quality of life. In a demographic situation globally with an increasing proportion of older adults up in very high ages it is a challenge to “keep older adults going” for as long as possible. It is therefore urgent to learn more about how to prevent and treat loss of muscle mass and function.

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