Maintaining muscle mass and preventing sarcopenia in the elderly: **important benefits of dairy**

AGING AND SARCOPENIA

Sarcopenia is defined as the age-related loss of skeletal muscle mass and strength.[1,2] This condition is associated with lower functional independence and disability3 that significantly impacts on the ability to perform activities of daily living4 and quality of life.[1,4].

In the United States, sarcopenia affects about 25-50% of adults between the ages of 70-80 years.[5,6] Although information about the nutritional status of elderly persons in developing countries is largely lacking, estimates indicate that about a third of South African elderly are underweight,[7] while more than half of older South Africans are overweight or obese.[8] In the elderly, overweight is often characterized by loss of lean muscle mass and micronutrient malnutrition, a condition termed sarcopenic obesity.[9] Life expectancy is on the increase and Cruz-Jentoft *et al.* (2010) estimate that over the next 40 years, 200 million adults will develop sarcopenia.

The clinical process involved in the development of sarcopenia originates from abnormal muscle mass or quality that progresses to muscle weakness, resulting in reduced physical function and disability.10 The condition is accelerated by aging, disease, inactivity and malnutrition.[2,10,11] The decrease in metabolically active skeletal muscle and increase in fat mass are associated with lower levels of fitness, reductions in metabolic rate and increased risk and prevalence of type 2 diabetes mellitus[12] as well as an increased risk of falling and hip fractures.[13] The mechanisms that are involved include lower production of anabolic hormones, reduction in insulin and growth hormone sensitivity, oxidative stress[5,11] and inflammation.[2,5,11]

EXERCISE AND SARCOPENIA

Sarcopenia is characterised by an imbalance between the rate of muscle protein synthesis and muscle protein breakdown.[12,14] This balance is determined by the intake of protein and the resultant increase in amino acids in the blood. After protein intake, muscle protein synthesis increases, while muscle protein breakdown is supressed. The opposite is true during fasting, when muscle protein synthesis decreases and muscle protein breakdown is slightly increased.[14]

Resistance exercise has the ability to increase muscle protein mass and strength,[2,4,11,14,15,16] which over time can result in improved muscle protein synthesis and muscle hypertrophy.[12,16] More recently the benefits of resistance training on muscle power and functional capacity have also been highlighted.[16] On the other hand, aerobic exercise is able to improve insulin sensitivity and decrease oxidative stress.16

Preserving muscle mass has a number of benefits, including maintaining metabolic rate and thus reducing risk of obesity and its comorbidities.[12,14] The benefits of exercise can be enhanced by nutrition interventions.[4] These include supplementation with essential amino acids, creatine monohydrate, essential fatty acids and vitamin D.[4,16] This review, however, will focus on the benefits of amino acids and milk-based proteins in maintaining and enhancing muscle mass in older adults.

AMINO ACIDS

Food and nutrition play important roles in supporting health and preventing disease.10 The amino acids that are provided by protein are necessary for growth and maintenance of muscle mass.[11,17,18] Essential amino acids are especially important in stimulating muscle protein synthesis[4,17] with leucine playing a pivotal role,[19,20,21] due to its ability to increase rate of protein synthesis.[13,19]

The term "anabolic resistance" refers to the age-related decrease in the ability of essential amino acids to enhance skeletal protein synthesis.[9,22] The result of anabolic resistance to dietary proteins may lead to a decrease in muscle mass and physical function, which is worsened by an inadequate diet that is low in energy and protein.[9,23]

MILK-BASED PROTEINS

According to Bonjour *et al.* (2013), "foods rather than nutrients are chosen

and consumed". A more cost-effective and practical strategy to improve muscle mass than supplementing essential amino acids or leucine, is to increase the intake of high-quality proteins from foods.[4] The intake of various types of proteins, however, impacts on muscle protein synthesis differently. These differences are related to the degree to which muscle protein synthesis is increased, as well as the duration of increased synthesis.[14,17,24] This is particularly important after resistance training,[14] and is thought to be determined by the amino acid composition of the protein as well as the rate of digestion.[14,17]

Dairy products have a high nutrient density and palatability, making them very beneficial in the diet of both healthy and frail elderly persons.[25,26] In addition, milk proteins have a high biological value and quality.[12,13,14,17] Whey and casein proteins are absorbed at different rates in the digestive system. Whey protein is thought to support rapid increases in muscle protein synthesis while casein is more likely to support sustained increases in muscle protein synthesis and decreases in muscle protein breakdown.[14,16,17,27] Whey proteins, also termed "fast proteins," remain in a liquid state in the stomach, thus increasing amino acid availability and absorption. On the other hand, caseins, or "slow proteins" clot in the low pH of the stomach, resulting in a slower availability of amino acids.[17] In addition to the whey and casein proteins that are present in dairy milk, it is also a very good source of leucine.[17,19,27,28] Gryson *et al.* (2013) have shown that the leucine in whey milk protein is more available than leucine from other protein sources.

REVIEWING THE EVIDENCE

A number of recent studies have assessed the impact of protein supplementation on muscle protein synthesis and muscle mass.[15,17,24,28,29,30,31,32,33] Comparison of studies is complicated by differences in the sample sizes; degree of sarcopenia in participants; level of frailty and fitness; type, duration and intensity of exercise programmes; as well as the type, quality, digestion rate and level of protein supplementation applied. The timing of consumption in relation to physical activity is also not consistent over studies.

A study by Hartman *et al.* (2007) in healthy young adults, showed that the intake of milk after resistance training over 12 weeks resulted in greater increases in muscle mass than groups that were supplemented with soy.[32] Another study by Wilkinson *et al.* (2007) compared the effects of skim milk and soy milk after single-leg exercise (leg press, leg curl, leg extension) in young healthy men and found that although both foods promoted muscle mass maintenance and gains, the consumption of skim milk resulted in greater muscle protein synthesis than the soy.[24] These researchers concluded that the consumption of milk with resistance training supports a lean muscle mass accrual.

Recently Bjorkman *et al.* (2011) undertook a randomised cross-over trial in older persons (mean age 69.5 years) with polymyalgia rheumatica. These participants consumed regular milk or a whey protein enriched dairy product with high leucine content for eight weeks. After a wash-out period of four weeks they consumed the other product for another eight weeks. They performed as many stand ups as they could twice a day after which they consumed either of the products. Improvements in muscle mass, walking speed and chair stand test performance were observed. The two products had similar effects on muscle mass and muscle function, but the whey product tended to prevent accumulation of body fat.[30] These results were confirmed in young adults who consumed different sources of milk-based proteins. The consumption of whole milk, skim milk, and skim milk plus carbohydrate all improved muscle synthesis after resistance training.[33]

Cermak et al. (2012) conducted a meta-analysis to examine if protein supplementation augments the effects of resistance exercise in younger and older subjects. Data from six randomized clinical trials related to the impact of protein supplementation in untrained older subjects were combined. Five studies included only dairy protein (whey, milk or casein) and one included a combination of egg, meat and dairy. Although the individual studies failed to find a significant benefit of protein supplementation versus placebo on fat free mass gain, the combined data from 215 older subjects showed that protein supplementation resulted in 38% more fat free mass and a 33% increase in strength when compared to placebo.[29]

One trial involving the intake of milk-based proteins during or after exercise in the elderly has reported conflicting results. A randomized-controlled trial in healthy middle-aged and older men by Kukuljan et al. (2009) could not demonstrate any added benefits of milk consumption over that of resistance exercise training alone.[31] In this trial, however, milk was not consumed directly after exercise, meaning that the benefit of exercise-induced blood flow and the potential of amino acids to improve muscle protein synthesis after exercise were not utilised.[16] The authors acknowledge that the timing of milk consumption as well as the fact that the healthy older men that participated in their study had an adequate energy and protein intake before intervention, could have been the reason for the lack of impact in that trial.[31]

CONCLUSION

There is a growing body of evidence showing that the intake of milk-based proteins has biological effects that may improve the beneficial effects of exercise, since these proteins are an effective protein source for stimulating muscle protein synthesis, slowing muscle protein breakdown and improving muscle mass. The anabolic effect of milk may be an effective, practical and cost-effective way for maintenance of muscle mass and strength in the healthy elderly and fast recovery in the frail and malnourished elderly.

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