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This review offers insight into the benefit of milk and dairy intake for maintaining muscle mass in the healthy elderly and promoting recovery in frail or malnourished elderly.

A publication for health professionals

Preventing sarcopenia:

Dairy protein and muscle mass maintenance in the elderly



Ageing 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 disability,[3,4] which significantly impacts on the ability to perform activities of daily living[5] and the quality of life.[5,6]

According to Cruz-Jentoft et al.,[1] the prevalence of sarcopenia is estimated at 1–29% among people who live independently in the community and 14–33% in those who live in long-term care facilities. 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 characterised 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.[6] estimate that over the next 40 years, 200 million adults will develop sarcopenia.

The clinical development of sarcopenia involves muscle tissue of abnormal mass or quality progressing to muscle weakness, resulting in reduced physical function and subsequent disability.[10] The condition is accelerated by ageing, disease, inactivity and malnutrition.[1,2,9,11,12] The decrease in metabolically active skeletal muscle and increase in fat mass are associated with lower levels of fitness, a reduction in metabolic rate and increased risk and prevalence of type 2 diabetes mellitus,[13] as well as an increased risk of falling and hip fractures.[11,14] The underlying mechanisms include lower production of anabolic hormones, reduction in insulin and growth hormone sensitivity, oxidative stress[12] and inflammation.[2,11,12]

Exercise and sarcopenia

Sarcopenia is characterised by an imbalance between the rate of muscle protein synthesis and muscle protein breakdown.[3,13,15] 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 suppressed. The opposite is true during fasting, when muscle protein synthesis decreases and muscle protein breakdown is slightly increased.[15] Resistance exercise has the ability to increase muscle protein mass and strength,[2,5,12,15-18] which, over time, can result in improved muscle protein synthesis and muscle hypertrophy.[13,16,18] The benefits of resistance training for muscle power and functional capacity have also been highlighted.[18] In contrast, aerobic exercise is able to improve insulin sensitivity and decrease oxidative stress.[18]

Preserving muscle mass has a number of benefits, including maintaining metabolic rate and thus reducing the risk of obesity and its comorbidities.[13,15] The benefits of exercise may be enhanced by nutrition interventions that include supplementation with essential amino acids, creatine monohydrate, essential fatty acids and vitamin D.[5,18] 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 have important roles in supporting health and preventing disease.[10] The amino acids provided by protein are necessary for growth and maintenance of muscle mass.[12,19] Essential amino acids are especially important in stimulating muscle protein synthesis,[5,19] with leucine having a pivotal role[1,20] owing to its ability to increase the rate of protein synthesis and so stimulate insulin secretion.[14]

The term 'anabolic resistance' refers to the age-related decrease in the ability of essential amino acids to enhance skeletal protein synthesis.[9,21] The result of anabolic resistance to dietary proteins may lead to a decrease in muscle mass and physical function, which is worsened by a diet low in energy and protein.[9,22]

Milk-based proteins

According to Bonjour et al. 'foods rather than nutrients are chosen and consumed'.[14] A more cost-effective and practical strategy to improve muscle mass than supplementing with essential amino acids or leucine, is to increase the intake of high-quality proteins from foods.[5] However, various types of protein affect 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.[15,19] This is particularly important after resistance training,[16] and is thought to be determined by the amino acid composition of the protein as well as the rate of digestion.[15,19] Dairy products have a high nutrient density and palatability, making them beneficial in the diet of both healthy and frail elderly persons.[23,24] In addition, milk proteins have a high biological value and quality.[13-15,19] 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, whereas casein is more likely to support sustained increases in muscle protein synthesis and decreases in muscle protein breakdown.[15,18,19] Whey proteins, also termed 'fast proteins', remain in a liquid state in the stomach, thus increasing amino acid availability and absorption. In contrast,

caseins ('slow proteins') clot at the low pH of the stomach, resulting in a slower release of amino acids.[19] In addition to whey and casein, milk protein is also a very good source of leucine.[1,19] Gryson et al.[19] have shown that the leucine in whey milk protein is more available than leucine from other protein sources.

Reviewing the evidence

Although some previous studies have assessed the effect of milk and dairy products on muscle protein synthesis and muscle mass, most randomised controlled trials (RCTs) have included nutrition interventions that supplemented dairy nutrients such as whey protein or leucine. The comparison of studies is complicated by: differences in sample sizes; degree of sarcopenia in participants; level of frailty and fitness; type, duration and intensity of exercise programmes, and the type, quality, digestion rate and level of protein supplementation applied. The timing of consumption in relation to physical activity is also not consistent across studies.

Alemán-Mateo et al.[25] completed an RCT in persons over 60 years of age (men and women). Participants in the intervention group consumed their habitual diet but added 210 g of ricotta cheese, while the control group consumed only their habitual diet. Participants were assessed at baseline and again after 12 weeks. A significant improvement in muscle mass (assessed using dual-energy X-ray absorptiometry) was observed in the intervention group compared with the control group.

Bjorkman et al.[26] 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-enriched dairy product with a high leucine content for eight weeks. After a wash-out period of four weeks they consumed the whey-enriched product for another eight weeks. Participants performed as many stand-ups as possible twice a day and then 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-enriched product tended to prevent accumulation of body fat. 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.

A study by Hartman et al.[27] in young, healthy adults showed that the intake of milk after resistance training over 12 weeks resulted in greater increases in muscle mass than in groups who consumed a soy supplement. Another study[28] 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 soy. These researchers concluded that the consumption of milk with resistance training supports lean muscle mass accrual.

Trials involving the intake of milk-based proteins during or after exercise in the elderly have reported conflicting results. An RCT in healthy middle-aged and older men by Kukuljan et al.[29] could not demonstrate any added benefits of milk consumption over that of resistance exercise training alone. 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.[18] The authors acknowledged that the timing of milk consumption and the participants' adequate energy and protein intake before intervention could have explained the lack of impact in that trial.[29]

A number of systematic reviews related to the impact of physical activity or dietary supplementation on sarcopenia have recently been published. In one such review, Cruz-Jentoft et al.[1] found that most exercise interventions (mostly resistance training) led to an improvement in muscle strength and physical performance. The small number of studies and heterogeneous study designs made it difficult to confirm the benefits of nutrition intervention. Essential amino acids, including leucine, did seem to improve muscle mass and function. Denison et al.[30] assessed the effect of combined exercise and nutrition interventions on muscle mass, strength and function in 17 studies in the elderly. Similarly, their review concluded that there was insufficient evidence to make definitive recommendations.

Beaudart et al.[3] recently reviewed 37 RCTs that investigated the effect of combined exercise and nutrition intervention on muscle mass and muscle function. They concluded that exercise has a beneficial effect on muscle mass and function in the elderly, but that the impact of dietary supplementation was limited.

Morton et al.[16] performed a systematic review to determine if protein supplementation enhances the impact of resistance training on muscle mass and strength in healthy adults. They included 49 RCTs that had run over six weeks or more and included both resistance training and protein supplementation. They concluded that protein supplementation (up to 1.6 g/kg/day) significantly improved changes in muscle strength and mass in healthy adults, but that the beneficial effects decreased with age. Similarly, the meta-analysis of Cermak et al.[31] included data from six RCTs related to the impact of protein supplementation in untrained older subjects. 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 with the placebo.

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, as these proteins are an effective protein source for stimulating muscle protein synthesis, delaying 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 in the healthy elderly and faster recovery in frail and malnourished elderly.

References

1. Cruz-Jentoft AJ, Landi F, Schneider SM, et al. Prevalence of and interventions for sarcopenia in ageing adults: A systematic review. Report of the International Sarcopenia Initiative (EWGSOP and IWGS). Age Ageing. 2014; 43(6):748-759.
2. Bautmans I, Van Puyvelde K, Mets T. Sarcopenia and functional decline: Pathophysiology, prevention and therapy. Acta Clin Belg. 2009; 64(4):303-316.
3. Beaudart C, Dawson A, Shaw SC, et al. Nutrition and physical activity in the prevention and treatment of sarcopenia: Systematic review. Osteoporos Int. 2017; 28(6):1817-1833.
4. Walston JD. Sarcopenia in older adults. Curr Opin Rheumatol. 2012; 24:623-627.
5. Candow DG, Forbes SC, Little JP, Cornish SM, Pinkoski C, Chilibeck PD. Effect of nutritional interventions and resistance exercise on aging muscle mass and strength. Biogerontology. 2012; 13:345-358.
6. Cruz-Jentoft AJ, Beavens JP, Bauer Y, et al. Sarcopenia: European consensus on definitions and diagnosis: Report of the European working group on sarcopenia in older people. Age Ageing. 2010; 39:412-423.
7. Charlton KE, Rose D. Nutrition among older adults in Africa: The situation at the beginning of the millennium. J Nutr. 2001; 131(9):2424S-2428S.
8. Kimokoto RW, Hamer DH. Nutrition, health, and aging in sub-Saharan Africa. Nutr Rev. 2008; 66:611-623.
9. Coker RH, Miller S, Schutzler S, Deutz N, Wolfe RR. Whey protein and essential amino acids promote the reduction of adipose tissue and increased muscle synthesis during caloric restriction-induced weight loss in elderly, obese individuals. Nutr J. 2012; 11:105-111.
10. Combs GF, Trumbo PR, McKinley MC, et al. Biomarkers in nutrition: New frontiers in research and application. Ann N Y Acad Sci. 2013; 1278:1-10. doi:10.1111/nyas.12069.
11. Yoo JI, Ha YC, Choi H, et al. Malnutrition and chronic inflammation as risk factors for sarcopenia in elderly patients with hip fracture. Asia Pac J Clin Nutr. 2018; 27(3):527-532.
12. Boirie Y. Physiopathological mechanism of sarcopenia. J Nutr Health Aging. 2009; 13(8):717-723.
13. Tang JE, Phillips SM. Maximising muscle protein anabolism: The role of protein quality. Curr Opin Clin Nutr Metab Care. 2009; 12(1):66-71.
14. Bonjour J-P, Kraenzlin M, Lavasseur R, Warren M, Whiting S. Dairy in adulthood: From foods to nutrient interactions on bone and skeletal muscle health. J Am Coll Nutr. 2013; 32(4):251-263.
15. Phillips SM, Tang JE, Moore DR. The role of milk- and soy-based protein in support of muscle protein synthesis and muscle protein accretion in young and elderly persons. J Am Coll Nutr. 2009; 28:343-354.
16. Morton RW, Murphy KT, McKellar SR, et al. A systematic review, meta-analysis and meta-regression of the effect of protein supplementation on resistance training-induced gains in muscle mass and strength in healthy adults. Br J Sports Med. 2017; 52(6):376-384.
17. Chale A, Cloutier GJ, Hau C, Phillips EM, Dallal GE, Fielding RA. Efficacy of whey protein supplementation on resistance exercise-induced changes in lean mass, muscle strength, and physical function in mobility-limited older adults. J Gerontol A Biol Sci Med Sci. 2012; 68(6):682-690.
18. Forbes SC, Little JP, Candow DC. Exercise and nutritional interventions for improving aging muscle health. Endocrine. 2012; 42:29-38.
19. Gryson C, Walrand S, Giraudet C, et al. 'Fast proteins' with a unique essential amino acid content as an optimal nutrition in the elderly: Growing evidence. Clin Nutr. 2014; 33(4):642-648.
20. Casperson SL, Sheffield-Moore M, Hewlings SJ, Paddon-Jones D. Leucine supplementation chronically improves muscle protein synthesis in older adults consuming the RDA for protein. Clin Nutr. 2012; 31(4):512-519.
21. Burd NA, Wall BT, Van Loon LJC. The curious case of anabolic resistance: Old wives' tales or new fables? J Appl Physiol. 2012; 112:1233-1235.
22. Niewenhuizen WF, Weenen H, Rigby P, Hetherington MM. Older adults and patients in need of nutritional support: Review of current treatment options and factors influencing nutritional intake. Clin Nutr. 2010; 29:160-169.
23. Drenowski A. The contribution of milk and milk products to micronutrient density and affordability in the US diet. J Am Coll Nutr. 2011; 30:422S-428S.
24. Van Staveren WA, De Groot LC. Evidence-based dietary guidance and the role of dairy products for appropriate nutrition in the elderly. J Am Coll Nutr. 2011; 30(5 Suppl 1): 429S-437S.
25. Alemán-Mateo H, Carreón VR, Macías L, Astiazaran-García H, Gallegos-Aguilar AC, Enríquez JR. Nutrient-rich dairy proteins improve appendicular skeletal muscle mass and physical performance, and attenuate the loss of muscle strength in older men and women subjects: A single-blind randomized clinical trial. Clin Interv Aging. 2014; 12(9):1517-1525.
26. Bjorkman MP, Pilvi TK, Kekkonen RA, Korpela R, Tilvis RS. Similar effects of leucine rich and regular dairy products on muscle mass and functions of older polymyalgia rheumatic patients: A randomised crossover trial. J Nutr Health Aging. 2011; 15:462-467.
27. Hartman JW, Tang JE, Wilkinson SB, et al. Consumption of fat-free fluid milk after resistance exercise promotes greater lean mass accretion than does consumption of soy or carbohydrate in young, novice, male weightlifters. Am J Clin Nutr. 2007; 86:373-381.
28. Wilkinson SB, Tarnopolsky MA, Macdonald MJ, Macdonald JR, Armstrong D, Phillips SM. Consumption of fluid skim milk promotes greater muscle protein accretion after resistance exercise than does consumption of an isonitrogenous and isoenergetic soy-based beverage. Am J Clin Nutr. 2007; 85:1031-1040.
29. Kukuljan S, Nowson CA, Sanders K, Daly RM. Effects of resistance exercise and fortified milk on skeletal muscle mass, muscle size, and functional performance in middle-aged and older men: An 18-mo randomized controlled trial. J Appl Physiol. 2009; 107:1864-1873.

30. Denison HJ, Cooper C, Sayer AA, Robinson SM. Prevention and optimal management of sarcopenia: A review of combined exercise and nutrition interventions to improve muscle outcomes in older people. Clin Interv Aging. 2015; 10:859-869.

31. Cermak NM, Res PT, De Groot LCPGM, Saris WHM, Van Loon LJC. Protein supplementation augments the adaptive response of skeletal muscle to resistance-type exercise training: A meta-analysis. Am J Clin Nutr. 2012; 96:1454-1464.

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