

Nutritional Strategies to Promote Muscle and Joint Health

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All around the world, as young adults move into middle and later life stages, attention to health-promoting factors is helpful in supporting an active lifestyle and in preventing fall-related injuries. With age, joints are affected by wear and tear as well as by systemic inflammation. Perhaps less well recognized is the dual role that muscle plays in terms of maintaining physical activity as well as in helping prevent falls. The World Health Organization (WHO) reports that falls are the second leading cause of unintentional injury-related deaths globally¹.

37.3
million falls
require medical
attention
annually
worldwide

Over
17 million
disability-adjusted
life years* lost
annually

Adults
over 65 years
experience the
highest death
rates due to falls
worldwide

Most
common in
low and middle
income countries,
especially in the
Western Pacific and
South East
Asia

*Disability-adjusted life years (DALYs) is a measurement of the number of healthy years of life lost due to disease or disability

Muscle and joint health is not only about living a physically active life, but also about preventing disabling and fatal falls.





Staying active in later life depends on building muscle mass and strength, preventing excess body fat, and supporting joint health starting in early adult years and then maintaining these behaviors throughout the later stages of life.

Before considering the role nutrients play in supporting the health of muscle and joint tissues, it is important to know a bit about their structures and factors that lead to decreased function.

Muscles and joints work together

Muscles and joints are part of the musculoskeletal system and work together, along with bones, in almost every body movement to maintain balance (see *Figure 1*). There are over 600 muscles in the body. Those connected to bones are called skeletal muscle. They are responsible for movement, protecting joints, and for balance to prevent falls. Maintaining healthy muscle includes both muscle mass and function (i.e. strength and power).

Joints occur where two bones come together and include the major movable joints in the shoulders, hips, and knees. In movable joints, a protective coating over the bones called cartilage protects bones from painful rubbing. Maintaining healthy joints depends on healthy muscle to stabilize joints, healthy bone and cartilage, and preventing inflammation in the fluids surrounding the joint.

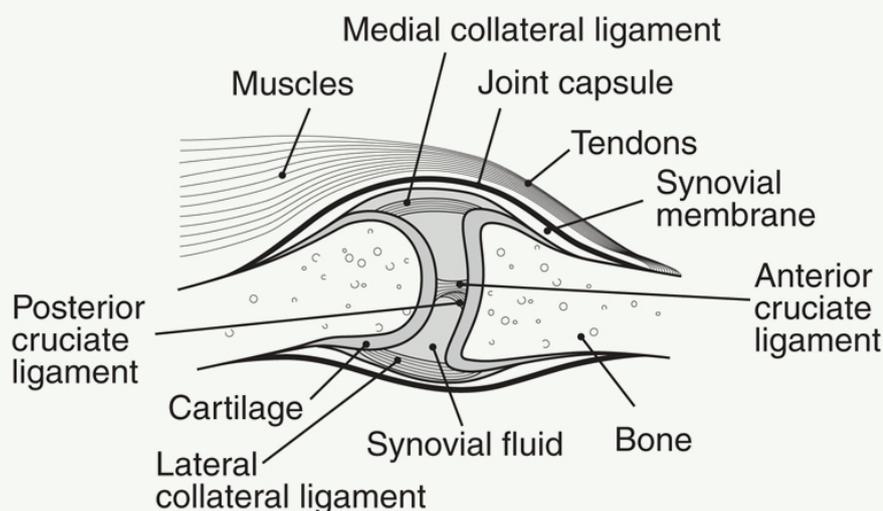


Figure 1: In healthy joints, the ends of the bones are encased in smooth cartilage and are protected by a joint capsule that is lined with a synovial membrane, which produces synovial fluid. Synovial fluid reduces friction between the articular cartilage of synovial joints during movement. Tendons connect muscles to bones near joints, which allows joint movement.

Illustration courtesy of the National Institute of Arthritis and Musculoskeletal and Skin Diseases.

Muscles and joints change as we age

As our bodies reach around 35 years of age and on, they begin to lose lean body mass and gain fat mass due to normal physiologic changes as well as lifestyles factors related to sedentary behaviors and diet. Even though weight may appear to be the same number on a scale, the composition of the body will still change; adults who maintain neutral body weight lose 1.5 kg (3.3 lbs) of muscle on average each decade².

Did you know?

We lose up to 40% of the cross-sectional area of our muscles between the ages of 20 and 60 years. This number is even higher in sedentary individuals³.



Age-related muscle loss impairs strength and power and can lead to a decreased ability to stabilize joints, resulting in joint misalignment and mechanical stress when the joint moves. In some cases, muscle loss is so great it is medically classified as sarcopenia - the loss of skeletal muscle mass and strength as a result of aging. Although we are bound to lose muscle mass as we age, the health benefits of resistance training, and possibly other types of exercise, on maintaining muscle health are well documented and, with diet, can help slow these age-related changes⁴.

As with muscle, joints also change around age 35 and over. Joints are composed of active tissues which are constantly being remodeled throughout life; as the body's ability to repair tissues is diminished, degeneration of joints accumulates over time⁵. In addition to age, factors like excess body weight, inflammation, injuries, and chronic degenerative conditions can contribute to joint pain and loss of joint mobility.



Obesity is a key modifiable factor in musculoskeletal health

Obesity appears to be a two-fold risk factor for musculoskeletal issues due to both the impact of body weight on joints as well as metabolic stresses associated with body fat⁸.

Carrying extra body weight can increase the impact of normal use-related wear and tear of joints associated with aging. Additionally, chronic inflammation related to both body fat and aging appears to be associated with joint health⁵. **Since six percent of disability-adjusted life years (DALYs) worldwide are attributed to musculoskeletal disorders⁶, preventing weight gain over lifespan may be an effective tool in improving quality of life in later years.**

Obesity is also a main and modifiable risk factor for osteoarthritis, a common form of joint degeneration characterized by a progressive loss of joint tissue. However, keep in mind that degenerative conditions such as arthritis are medical conditions that require treatment by health professionals and therefore are not the focus of this overview.

Did you know?

In developed countries, 2 out of 3 adults are overweight by 55 years of age among men and by 60 years of age among women.

Prevalence of overweight is increasing in developing regions as well, with 14% of women overweight by 55 years of age and 8% of men by 45 years of age⁷.

Dietary factors to support muscle health

Dietary protein is essential to build and maintain muscle mass throughout the lifespan. Current protein recommendations by the World Health Organization (WHO) are based on amounts needed to achieve body nitrogen equilibrium, assuming an individual has an appropriate body composition, is in energy balance, and at moderate physical activity⁹. Based on these criteria, 0.8 g protein/kg body weight each day would meet requirements for most healthy adults⁹. Nevertheless, there is active scientific debate as to whether higher levels of protein, around 1.0-1.2 grams per kilogram of body weight, would be beneficial for skeletal muscle health^{10, 11}. In a position paper, the PROT-AGE Study Group recommended daily protein intakes for people 65+ years of age be increased to 1.0 - 1.2 g protein per kilogram of body weight, and even higher among exercising and otherwise active older adults¹¹.

In addition to total protein intake, the amino acid leucine plays a unique role in helping stimulate muscle synthesis¹², a response that diminishes in older adults¹³. Eggs, soy, and dairy are relatively more concentrated sources of leucine¹⁴.

There is accumulating evidence that vitamin D benefits muscle mass and strength, although findings are mixed due to heterogeneity in measures and populations studied.



According to Mithal et al., collective findings “indicate a role for vitamin D in the development and preservation of muscle mass and function”¹⁰. In a small experimental study, long chain omega-3 fats showed an anabolic muscle protein response to stimulation by hyperaminoacidemia and hyperinsulinemia over eight weeks¹⁵. Whether omega-3 rich foods or supplements help maintain muscle over the long term in the general population remains an area of interest. Other dietary components have been associated with building and maintaining muscle, but evidence is either inconclusive or still emerging¹⁰.



Diet and nutritional factors to support joint health

Body weight is one of the most effective modifiable risk factors for joint health and the only dietary factor with strong evidence linked to joint health^{8,16}. Preventing weight gain and maintaining lean body muscle by balancing calorie intakes with energy expenditure, while ensuring adequate protein, is solid advice for overall health and mobility.

Vitamin C is essential for the body to make collagen, an important part of the cartilage that protects the ends of bones in joints. It is also an antioxidant, which helps the body protect damage to tissues like cartilage. Eating a diet rich in fruit and vegetable sources of vitamin C provides sufficient nutrients to build and maintain normal healthy joints as well as maintain healthy body weight, which prevents excess stress on joints. More vitamin C does not stimulate the body to build more cartilage in humans. However, in the 1990's one observational study reported that higher dietary vitamin C intake was associated with lower risk of developing knee pain and, among persons with osteoarthritis, lower risk of cartilage loss¹⁷. Overall, dietary intakes of antioxidant vitamins (C, E or carotenoids) were not associated with incidence



of osteoarthritis. Current Dietary Reference Intakes (DRI's) for vitamin C do not state joint health as a function beyond its role as a nutrient essential for building collagen¹⁸.

Although not typically found in foods we eat, there are some components commonly taken as supplements with the intent of helping support healthy joints. Chondroprotectives, like glucosamine, chondroitin, hyaluronic acid, and s-adenosylmethionine (SAME), are among supplemental ingredients with some evidence of benefit^{19,20,21}. These protective ingredients may provide building blocks for joint cartilage and synovial fluid or they may affect osteoarthritis through other mechanisms, such as reducing inflammatory actions that negatively affect

joint cartilage and increase joint inflammation. In addition to these supplements, antioxidants and anti-inflammatory components are being actively researched to determine their roles in supporting healthy joint tissues or even in treating inflammation associated with arthritis. These include omega-3 fatty acids, antioxidant vitamins (C, A, and E), bioactive components of fruits, vegetables, teas, spices and nuts, as well as herbal therapeutics, like the resin from the *Boswellia serrata* tree relative to osteoarthritis^{21,22}. A Cochrane systematic evidence review of herbal therapy for rheumatoid arthritis showed probable evidence for reducing pain for oils containing gamma-linolenic acid (GLA), but uncertainty for most herbal therapies²³. Although supplements are often taken to either prevent problems or alleviate joint pain, arthritis is a medical condition for which medical treatment is advised.



Translating the science into product ideas to promote muscle and joint health

Maintaining muscle mass and a healthy weight are the most effective dietary methods of promoting muscle and joint health. There is evidence that spreading protein intake throughout the day can be beneficial for muscle mass growth and retention even in aging populations (see our article [Three Things You Need to Know About Protein for Exercise Performance](#)). Snack products that are rich in protein foods, whole grains, fruits, and vegetables would be beneficial in providing our bodies the protein, vitamins, and minerals our bodies need to maintain muscle and joint health. Keeping portion sizes of these products sensible while limiting added sugar content will promote healthy weight, furthering their benefit to joint health.

Unfortunately, food manufacturers are somewhat limited in the package claims that can be made about nutrition and joint health. The bulk of research on nutrition and joint health is done in osteoarthritic joints, meaning this science cannot be used to support the relationship between a nutrient and prevention of a health-related condition on a product package (see FDA Docket No. 2004P-0059). The docket does conclude that cartilage degeneration is a modifiable risk factor for osteoarthritis, meaning study outcomes measuring cartilage degeneration in a generally healthy population would be most appropriate for supporting future potential joint health nutrition claims.

The good news is that products which help consumers maintain muscle mass and a healthy weight will also contribute to two of the top five things consumers are looking for from nutrients in a food: weight management (#1) and healthy aging (#4), according to the IFIC Food & Health Survey 2016. Thus, these foods can promote joint health without the need to specifically make a claim on the package.



In Summary

Diet and exercise are key to successful muscle and joint health starting in young adult years and continuing throughout aging. The combination of a healthy and nutritious, energy balanced diet, along with exercise, can help maintain muscle mass and function, prevent excess body fat accumulation, and support structural components of joints. Muscle mass and strength depend on eating sufficient amounts of protein, with potential benefits from ingesting total protein at levels higher than WHO recommendations, particularly among older adults. Choosing leucine-rich foods (like dairy, eggs, or soy) may help stimulate muscle synthesis needed to maintain muscle with aging.

More than any other dietary factor, joint health is greatly affected by the accumulation of excess body weight that occurs with aging. Therefore, preventing weight gain with age is key, including eating a nutrient rich diet emphasizing fruits and vegetables. There are no magic bullets to prevent age-related joint pain and chronic conditions like arthritis. Consumers frequently take supplements for joint health and although evidence is mixed, there are indications that they may provide structural support or act as anti-inflammatory agents in promoting healthy joints.

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