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Masters athletes face unique physiological and nutritional challenges

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Opening Commentary

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Regardless of age or level of ability, I am a firm believer that being healthy and fit should be a goal we all strive to achieve. For more than 30 years, I have coached and encouraged people of all backgrounds to take a holistic approach to personal wellness that enhances the mind, strengthens the body, and nurtures the spirit.

Taking a holistic approach means that in order to achieve a healthy lifestyle, we must pay close attention to our energy balance equation. In addition to regular physical activity, good nutrition is also critical to ensuring athletes maintain a competitive edge as they age, and reach new heights in their sports or recreational activities throughout their lifespan. Proper nutrition includes staying hydrated and consistently consuming complex carbohydrates, lean proteins, and healthy fats. When older "masters" athletes are fueled by the right nutrients, they can achieve better performance outcomes.

I was once an avid student and later became an instructor of karate. Like other sports, karate requires a regimented, intensive training routine that includes mental preparation as well as strength training and conditioning. In addition to the physical training, though, healthy eating habits have kept me energized, motivated, and prepared to compete at a high level and train others in a variety of sports and disciplines throughout my life including now, as a grandfather.

In this issue, Stella L. Volpe, PhD, RD, LDN, FACSM, and Rachel C. Kelley, BS, look at the recent rise in masters athletes and explore their unique nutritional needs. The article reviews the physiological changes that occur with age and the specific nutrition requirements for these athletes to perform at their best.

> "Good nutrition is critical to ensuring athletes maintain a competitive edge as they age, and reach new heights in their sports or recreational activities throughout their lifespan."
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> Cornell McClellan

Masters Athletes: Competitive Sports and Sports Nutrition for Older Adults

Masters athletes have diverse activity goals that range from elite competition to recreational exercise for optimizing health and independence.

Introduction

There has been a recent rise in competitive older athletes, also known as masters athletes.[1] Participation in the National Senior Games, events for athletes 50 years of age or older, exemplifies this trend. For example, in the 1987 National Senior Games in St. Louis, Missouri, 2,500 competitors registered for the events, and in the 2007 games in Louisville, Kentucky, this number increased to 12,000 competitors.[2] Not only are masters athletes more common than in years past, but they are also more competitive. In the 1986 Hawaii Ironman Triathlon, 31% of the male participants were greater than or equal to 44 years of age, and 23% of the female participants were greater than or equal to 40 years of age.[3] In 2010, these percentages increased to 53% and 47%, respectively, and performance times of these masters athletes improved in swimming, cycling, and running compared to previous age-matched finishers.[3] Researchers also reported similar trends in the New York City Marathon.[4] Athletes 50 years of age or older increased their participation and improved their running times at greater rates than their younger counterparts from 1983 to 1999.[4]

"Masters athletes" is a term that encompasses a wide range of active individuals. The age at which an individual qualifies for masters-level competition depends on the nature of the specific event. The sports with higher aerobic and flexibility demands start masters athletic categories at younger ages, while those sports that preferentially require skill start those categories at older ages.[5] For example, the first masters category in swimming includes athletes who are 19 to 24 years of age, and the masters categories continue in increments of 5 years, up to 90 to 94 years of age.[5] For golf, however, the first masters category begins at 50 years of age.[5] In most athletic events, masters athletes include those individuals who are 21 years of age or older.[6]

Masters athletes have diverse activity goals that range from elite competition to recreational exercise for optimizing health and independence.[7] Masters athletes and their coaches, physicians, dietitians, and other healthcare professionals need to be aware of changes in physiology that occur with age. Depending on the athlete's goals, they can use this information to develop exercise and diet plans that will promote a competitive edge and improve health without adding risk.

Current Problem

The reality for older adults is that endurance and strength capacities decline with age. Older individuals are more likely to have decreased cardiac output, hypertension, increased resting heart rate, and diminished heart function.[8] These changes contribute to a steady decrease in maximal oxygen consumption (VO_2max) per decade in masters athletes who are 25 to 65 years of age. This decrease ranges from 2.8 to 4.2 milliliters of oxygen per kilogram of body weight per minute (mL/kg/min).[5] Although some controversy exists in the field, most researchers have shown that this decline is even greater, 5 to 6 mL/kg/min, in sedentary individuals.[5,9] Physical impairments such as strains, injuries, lumbar disc disease, and osteoarthritis are also increased concerns for older adults.[2] Age-related reduction in muscle mass, which has been shown to decrease 1.25% each year after age 35, with or without activity, may contribute to these issues.[8] Changes also occur in metabolism as one ages. These changes include decreased metabolic rate, insulin sensitivity, appetite, gastric emptying, gastric acid, and digestive enzymes.[2,8] Thus, older individuals may have higher needs for protein and certain vitamins and minerals than younger adults.[2]

Table 1. Possible Age-related Physiological Changes That May Influence Exercise Performance in Masters Athletes

- 2.8 to 4.2 mL/kg/min decrease in VO2max every decade between 25 and 65 years of age (5 to 6 mL/kg/min decrease if sedentary)
- 1.25% decrease in muscle mass every year after 35 years of age
- Reduced cardiac output
- Increased resting heart rate
- Diminished left ventricular function
- Vulnerability to injury or re-injury
- Age-associated anabolic resistance
- Presence of chronic conditions
- Reduced hormonal concentrations

Based on research summarized by Kibler et al.,[8] Shephard,[5] Anish,[2] and Foster et al.[1]

Definitions: mL/kg/min = milliliters of oxygen/kilogram of body weight/minute; VO_2max = maximal oxygen consumption

Masters athletes should take comfort in the fact that physical activity will lessen most of the physiological declines mentioned previously and highlighted in Table 1. Thus, healthcare professionals should encourage exercise in older adults at the elite or recreational levels. Researchers have shown that sedentary individuals reach the aerobic fitness needed to maintain independent living, approximately 15 mL/kg/min, around 80 to 85 years of age; however, active adults prolong reaching this threshold by 10 to 20 years.[5,10] Furthermore, elite athletes should not feel discouraged from competing as they age. Signorelli et al.[11] measured maximal heart rate, VO_2max, and general flexibility in professional soccer players from two age groups: 17 to 22, and 27 to 36 years of age. They concluded that the younger and older players began the soccer season in identical training states.[11] Additionally, other researchers have reported that 70-year-old competitive athletes are more physically fit than untrained persons who are 40 years of age.[12]

*In spite of physiological changes that come with age, **elite athletes** should not feel discouraged from competing as they grow older.*

Table 2. General Sports Nutrition Guidelines for Athletes of All Ages

- Eat a balanced diet: 45% to 65% carbohydrate, 10% to 35% protein, 20% to 35% fat
- 7 to 10 g/kg/day carbohydrate
- 1.2 to 1.7 g/kg/day protein
- Consume 30 to 60 g/hour of carbohydrate if exercising intensely more than 1 hour
- Consume a recovery snack within 90 minutes of exercise
- Break up protein to 20 g portions every 4 hours after strength trainings

Based on research summarized by Rodriguez et al.[15] and Areta et al.[21] For more information on general healthy eating, please refer to a previous *Research Digest* article written by Volpe et al. (2013).[52]

Definitions: g/kg/day = grams/kilogram of body weight/day

*Masters athletes can **maintain a healthy body weight** as they grow older, despite age-related decrease in resting metabolic rate (RMR), due to their increased activity.*

Nutritional Recommendations

Diet planning for masters athletes follows most of the same principles as diet planning for active younger adults. For sedentary older individuals, the age-related reduction in resting metabolic rate (RMR) plays a major role in constructing diets that will achieve a healthy body weight.[13] This concern is not relevant for masters athletes. They will maintain or increase their total daily energy expenditure, despite any possible decrease in RMR because of age, due to their increased activity.[6,14] Intensely active older adults should focus on consuming enough calories, much like younger athletes, to optimize performance and maintain muscle mass. Future research should seek to develop RMR prediction equations that are specific to masters athletes so that registered dietitians can accurately estimate energy needs in this population.

Masters athletes should adhere to the sports nutrition guidelines established by the evidence-based joint position statement by the American College of Sports Medicine, Academy of Nutrition and Dietetics, and the Dietitians of Canada, which is highlighted in Table 2.[15] This statement recommends the following macronutrient distribution ranges: 45% to 65% carbohydrate, 10% to 35% protein, and 20% to 35% fat.[15] Depending on the intensity of an athlete's training and his or her absolute calorie needs, an athlete may need a different breakdown of macronutrient distribution ranges. During training periods, endurance athletes should consume 7 to 10 grams/kilogram body weight/day (g/kg/day) of carbohydrate, and ultra-endurance athletes should aim for greater than 10 g/kg/day.[14,15] Additionally, masters athletes should still follow the general recommendation to consume around 30 to 60 grams of carbohydrate per hour of exercise.[15] Similarly, the recovery carbohydrate recommendation of 1.5 g/kg within 90 minutes remains relevant for older competitors in endurance events.[14,15] Masters athletes should also adhere to these general health recommendations: make carbohydrate choices mainly from whole grains; choose lean protein foods; and focus on healthy mono- and polyunsaturated fats versus saturated fats.[6]

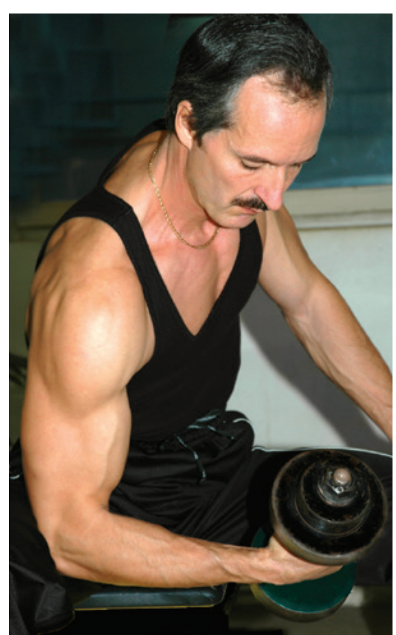
Despite the similarities in diet recommendations for athletes of all ages, masters athletes present with some unique concerns. Masters athletes should be aware that the Dietary Reference Intakes (DRIs) for vitamin D, calcium, and vitamin B_6 increase after 50 years of age.[14] Supplements of, or foods fortified with, folate and vitamin B_{12} may be necessary because of age-associated cognitive risks and reduced production of gastric acid needed for absorption, respectively.[13,14] Other areas of nutrition research that have more complex findings and recommendations for masters athletes include: protein, vitamin D, and antioxidant intakes, which will be described in more detail in the following sections.[13,14,16]

Protein

The protein needs of all athletes increase from the 0.8 g/kg/day recommendation for healthy sedentary individuals to a range of 1.2 to 1.7 g/kg/day, depending on the volume of exercise.[15] This increased intake may be especially important for older athletes. Several researchers have shown that age-related declines in muscular strength and mass may be related to a reduced sensitivity to exercise.[16–19] This reduced sensitivity would slow the rate of muscle growth. Fujita et al.[18] studied muscle protein synthesis rates in healthy older adults approximately 70 years of age. Study participants received a continuous infusion of labeled amino acids and either a normal dose of insulin or an above-normal dose. The researchers reported that only individuals who received the higher dose of insulin experienced increases in muscle protein synthesis rates, blood flow needed for nutrient delivery, and certain markers of insulin signaling.[18] Thus, even in healthy older adults who do not have type 2 diabetes mellitus, there may be age-related insulin resistance.[18] This insulin resistance may contribute to the development of sarcopenia (i.e., the general loss of muscle mass) and reductions in strength.[18] Additionally, Durham et al.[20] stated that muscle protein synthesis was reduced by 40% in healthy older adults compared to younger adults after an acute bout of endurance exercise. This result suggests not only impaired muscle growth in response to insulin, but in response to exercise as well. The participants in both of these studies, however, did not participate in regular exercise training programs. Future research should determine whether or not age-related anabolic resistance could account for decreases in performance in those who have exercised throughout their lives, such as masters athletes. But to err on the side of caution, older athletes, even more so than their younger counterparts, should focus on adhering to recommendations for amount and timing of protein consumption. This strategy will maximize muscle growth and strength.

Masters athletes should obtain the majority of their protein from whole foods like meat, fish, egg whites, and milk, because the amino acids from these sources are easily absorbed.[16] Pairing sufficient intake of high quality sources of protein with resistance training may overcome age-associated declines in muscle mass.[19] Timing of protein intake post-exercise may also help to maximize muscular growth and strength. Areta et al.[21] demonstrated that during the 12 hours after resistance training, consuming whey protein isolate, a protein supplement used in this experiment, in 20-gram increments every 3 hours was the best strategy to boost muscle protein synthesis. Consuming the same amount in 10-gram portions every 1.5 hours or in 40-gram portions every 6 hours was not as effective.[21] These researchers utilized a supplement to control for protein quality, but athletes should consume whole food sources after a workout. Pennings et al.[22] studied casein protein intake in older men. They reported that the use of casein protein for muscle fiber development was significantly higher if the men consumed the protein after 30 minutes of exercise, versus rest.[22] Adherence to a strength training regimen and proper protein intake will help promote better performance with age. Because age-associated insulin resistance may be present in some masters athletes, they should also consider combining this protein with some carbohydrate (approximately 50 grams). This additional carbohydrate would not only help restore glycogen stores and meet energy needs, but it would enhance the insulin response as well.[23] Whether or not combining carbohydrate with protein provides additional performance benefits for athletes remains controversial. However, the possibility that older healthy individuals may lose insulin sensitivity makes the recommendation a prudent one for masters athletes.

*Adherence to a **strength training regimen** and **proper protein intake** will help promote better performance with age.*



Vitamin D

Another nutrient of concern for masters athletes is vitamin D. The majority of the body's supply of vitamin D comes from the skin's ability to make the vitamin from sunlight. Therefore, vitamin D status is not problematic in some of the athletes who train and compete outdoors. As individuals age, however, the efficiency of this process decreases.[13,24] Although there are vitamin D-fortified foods, such as milk, yogurt, and orange juice, as well as a few natural dietary sources, such as salmon, sardines, and egg yolks, it is difficult to meet vitamin D recommendations through diet alone. Thus, older individuals often need to take supplements to obtain enough vitamin D in their diet.

There are many possible performance and health benefits associated with adequate vitamin D status.[25] The vitamin is essential for general bone health and the prevention of osteoporosis and injury.[24] It is interesting that researchers have discovered vitamin D effects in muscle.[26] Given these recent findings, Grimaldi et al.[27] evaluated upper and lower body muscular strength and serum vitamin D levels in 419 men and women 20 to 76 years of age. They reported that those adults with higher blood levels of vitamin D demonstrated better strength, especially leg strength.[27] Barker et al.[28] conducted a randomized placebo-controlled vitamin D supplement trial in healthy adults and found that the additional vitamin D in the supplemented individuals (those who took the extra vitamin D) assisted in their recovery from intense resistance exercise. After 28 days of treatment and a single-leg strength exercise, the group that took the vitamin D supplements exhibited better recovery and fewer molecular markers of muscle damage than the placebo group.[28] Even though researchers could not link these results to lower feelings of muscle soreness, any potential recovery aid is applicable to masters athletes, who may require longer rest periods between workouts.

Older individuals often need to take supplements to obtain enough vitamin D in their diet. The vitamin is essential for general bone health and the prevention of osteoporosis and injury, and it may also assist in muscle recovery from intense resistance exercise.

Antioxidants

Another new area of research that is especially relevant for masters athletes is antioxidant supplementation. The popular and scientific media have claimed that antioxidants protect against poor health outcomes like tissue damage, cardiovascular disease, cancer, and aging.[29–31] The proposed reason behind this protective effect is that antioxidants reduce oxidative stress, which may cause cell damage. Oxidative stress involves molecules known as free radicals. Free radicals are highly reactive, and they can attack cellular membranes, proteins, and deoxyribonucleic acid (DNA). Free radicals can originate from exposure to toxins or radiation as well as from injury and inflammation,[32] but the majority of free radicals are byproducts of normal energy production.[30,33] Thus, exercise is a significant source of these molecules.[29]

Exercise leads to oxidative stress and the accumulation of this free radical damage is a leading hypothesis for aging.[33] Furthermore, excessive amounts of free radicals cause decreases in muscle force, as well as more rapid muscle fatigue.[34] Thus, at first glance, antioxidant supplementation would seem to be an easy recommendation for all exercising individuals, especially masters athletes. However, the issue is much more complex. Free radical production during exercise is one way in which the body detects the stress of physical training and adapts to it. Free radicals trigger changes like increases in muscle fiber size, generation of more blood vessels in muscle, and improvements in the body's own antioxidant systems, which improve an individual's physical fitness and health.[34,35] Insufficient levels of oxidative stress will not properly activate cell processes necessary for these exercise adaptations, force production, and longevity.[30,34–40]

*Brazil nuts are one source of the antioxidant **selenium,** which provides improved immunity, cognitive protection, and reproductive and thyroid health.*

Table 3. Sources of Various Antioxidants and Possible Health Outcomes

Antioxidant	Dietary Sources	Health Outcomes
Vitamin A	Sweet potatoes, liver meats, spinach, carrots, cantaloupe, mango, broccoli	• Improved immunity • Optimal eye health • Healthy cell growth and differentiation
Vitamin C	Red bell peppers, citrus fruits, strawberries, tomatoes, Brussels sprouts	• Improved immunity • Recycling of other antioxidants • Healthy connective tissue formation
Vitamin E	Sunflower seeds, almonds, hazelnuts, peanuts, green vegetables	• Improved immunity • Prevention of coronary heart disease • Anti-inflammation and anti-cancer
Selenium	Liver meats, seafood, Brazil nuts, turkey, chicken, brown rice, oatmeal	• Improved immunity • Cognitive protection • Optimal reproductive and thyroid health

Based on research summarized by the National Institutes of Health.[51] For more information on general healthy eating, please refer to a previous *Research Digest* article written by Volpe et al. (2013).[52]

The optimal intake of antioxidants, one which is low enough to avoid damage and fatigue yet high enough to maintain healthful adaptation, is difficult, if not impossible, to achieve by taking supplements. Results from various antioxidant supplementation studies have been positive (good effects),[41–43] negative (bad effects),[44,45] and neutral (no effects).[46,47] Importantly, masters athletes have not been included in many of these studies, and their age may alter their antioxidant requirements. Miranda-Vilela et al.[48] reported that supplementation with pequi fruit pulp oil, an oil that contains antioxidants, may have health benefits for endurance-trained males 45 years of age or older. This crossover study required participants, 125 runners between the ages of 15 and 67 years of age, to consume 400 mg/day of the oil for 2 weeks before completing a race of the participants' usual distance. The trial's findings are limited because it lacked a placebo (or control group) and included runners who trained at various distances.

Nevertheless, there was a general trend of reduced inflammation and total and low-density lipoprotein (LDL) cholesterol in older runners, especially males.[48] Additionally, Louis et al.[49] conducted a 3-week double-blind vitamin and mineral supplement trial in endurance-trained masters cyclists. They concluded that the supplemental antioxidants reduced signs of muscular fatigue compared to the placebo. However, researchers could not link these results to significant differences in performance.[49]

Based on recent studies, masters athletes should consume antioxidants through whole foods rather than overwhelming their systems with supplements. Furthermore, the multiple antioxidants present in foods work together to reduce oxidative stress. Whole foods also have beneficial compounds that still remain unknown or impossible to replicate. Using food frequency data from the Hertford Shire Cohort Study, a database of the antioxidant content of foods, and results from glucose tolerance tests, Okubo et al.[50] demonstrated an inverse relationship between impairments in glucose metabolism and dietary antioxidant intake (i.e., those individuals who consumed more antioxidants in their diet were less likely to show abnormalities in glucose metabolism). The 1,441 men and 1,253 women were 59 to 73 years of age, and the better fasting and post-meal insulin and glucose values were significantly correlated with higher intakes of antioxidant-rich foods.[50] Given that age-associated insulin resistance is likely to occur, masters athletes, like all older adults, should focus on incorporating antioxidant-rich foods into their diets, like deep-colored fruits and vegetables (e.g., blueberries, raspberries, tomatoes, broccoli, kale, etc.).[6] Some of these foods are listed in Table 3.

Masters athletes, like all older adults, should focus on incorporating antioxidant-rich foods— like deep-colored fruits and vegetables— into their diets.

Conclusion

The majority of training and nutrition recommendations for active adults also pertain to masters athletes. As masters athletes continue to grow in numbers and remain competitive, researchers will discover unique aspects of this population's exercise physiology. Future studies will illuminate specific nutrition needs and the success of alternative therapies like antioxidant supplementation in these individuals. Armed with this knowledge, training and healthcare professionals will be prepared to advise masters athletes on specific exercise and nutrition strategies that will enhance athletic performance. The future looks bright for older competitors who seek to stay in the game.

Scientific Summary

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In this issue of *Elevate Health,* Rachel Kelley, BS, and Stella Volpe, PhD, RD, LDN, FACSM, from Drexel University address the important topic of nutrition recommendations for older adults in competitive sports. As the number of masters athletes escalates, this topic area becomes more and more important. As Ms. Kelley and Dr. Volpe outline, nutrition for masters athletes follows many of the same principles as for all other adults; however, there are some important differences. Depending upon weight status and athletic participation, calorie and protein needs may differ. Additionally, there are some nutrients of special concern for older adult athletes, such as vitamin D. Importantly, older adult athletes are at risk for chronic disease and functional decline, as are all older adults. The guidance provided in this paper will help practitioners guide masters athletes to improve overall health and to help them reach their full athletic potential now and in the future.

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