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EXERCISE AND NUTRITION

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"Overwhelming evidence indicates that regular physical activity is one of the most powerful health-promoting practices that physicians and other health care professionals can recommend for patients." Research shows that regular physical activity is protective against all types of chronic diseases (including high blood pressure, type 2 diabetes, obesity, heart disease, stroke, osteoporosis, cognitive decline, a number of cancers, and even depression). It aids in alleviating problems such as fatigue, osteoarthritis, joint pain due to instability, meniscal tear, tennis elbow, anxiety, sarcopenia (loss of muscle with aging), and more. It improves balance, agility and coordination. Exercise is beneficial before and after knee, hip and other joint replacements. It helps older people stay cognitively sharp, improves problem-solving skills and other mental abilities. Truly, "no other single intervention or treatment is associated with such a diverse array of benefits." Acquiring and maintaining muscle, for example, is important in blood sugar regulation, prevention of falls and injuries, amino acid storage that affects many areas such as the digestive tract lining and immune system, and more. Muscle strength is associated with a 20 to 30% lower risk of all causes of death (except cancer). Ideally, fitness activities should include aerobic exercise, strength (resistance) training, flexibility activities, and balance exercises. [1]

Energy drinks and **sports supplements** are popular. Claims made for many of them may or may not cite scientific references. When they are cited, most either can't be evaluated or are poor-quality studies. Some energy drinks contain one or a few separated 'antioxidants.' But there is little or no evidence to support claims that they enhance exercise/work performance, reduce recovery time, fight fatigue, or neutralize free radicals produced by exercise. Green tea with its naturally-occurring epigallocatechin gallate (EGCG) can benefit energy, recovery after exercise, and fat oxidation. But isolated EGCG in supplements can cause problems such as liver toxicity, especially in high pharmaceutical doses. A comparison between milk and a carbohydrate-electrolyte drink showed no difference in exercise capacity. Key ingredients in most energy drinks are caffeine (often a hefty dose not disclosed on the labels) and refined sugars (often as much, ounce for ounce, as soda. Many are a concoction of stimulants and other compounds that can adversely affect the cardiovascular system and other areas. Blood pressure can rise as can norepinephrine (a stress-related neurotransmitter). About two dozen deaths have been linked to high-(isolated)-caffeine energy drinks plus hundreds of adverse events such as seizures and cardiac arrest. Sports supplements are usually composed of isolated and/or synthetic nonfood 'nutrients.' Some add hormones that can be harmful. Those containing growth hormones can promote diabetes, cardiovascular disease, cancer, and other banes. Lean body mass may increase a little, but it doesn't confer improvement in strength or exercise capacity. Actually, quality foods (especially proteins) improve growth hormone (GH) production and tissue repair. Refined carbohydrates like sugar suppress GH production. Any "muscle-building" supplement claiming to mimic or affect hormones may contain synthetic steroids or steroid-like substances that can cause kidney or liver damage, hormone imbalances, increased risk of testicular cancer in men, or other adverse effects. "Dietary supplements for muscle building, weight loss, and sexual enhancement are at the highest risk of containing prohibited substances." [2]

CAFFEINE, **not** isolated, as in coffee and herbs (guarana, yerba mate), can increase performance. Caffeine may reduce the perceived level of exertion, making exercise feel easier. It activates the central and peripheral nervous systems, spares muscle glycogen, and improves glucose absorption. It shifts the body toward a heavier reliance on fat from subcutaneous areas and muscles (one reason why it improves long-distance performance). It may have more benefit when consumed with carbohydrates which may also enhance recovery from exercise. It may help mental alertness plus improve reaction time, attentiveness, and visual information processing. Coffee should be limited to one or two cups per day and taken in the morning, before exercise, not after (when it would inhibit protein synthesis in muscles). If exercising in the evening, skip the pre-workout cup of coffee as it can disrupt the sleep cycle. The energy-producing effect of caffeine is highly variable and depends on usual intake. Finding the right amount takes trial and error. An excess may induce tachycardia, tremors, insomnia, anxiety and irritability that could hurt, not help, performance. [3]

HERBS. Adaptogens are among the most useful herbs for athletes and regular exercisers. They have various abilities to increase resistance to different chemical, biological, and physical stressors, allowing the body to be better able to respond appropriately to diverse demands. Rhodiola rosea is a useful adaptogen for performance. It increases work performance and decreases fatigue and depression, providing an extra boost. Ginseng (Asian and Korean) is another helpful adaptogen though studies on physical performance have yielded mixed results. Ginger and cinnamon both help to reduce post-exercise muscle inflammation. Ginger reduces muscle soreness and may attenuate muscle pain induced by repetitive exercise. Fenugreek seeds contain a unique amino acid not found in muscle tissue (4-hydroxyisoleucine). This amino acid appears to help muscle glycogen recovery—increasing its glucose and insulin concentrations, thus improving glycemic control. Lemon verbena may help to protect against chronic exercise-induced muscular damage and oxidative stress. [4]

AMINO ACIDS. **Creatine** (glycine, arginine and methionine) is transported to and stored in muscles for use in producing ATP (adenosine triphosphate for cellular energy). Our kidneys and liver produce it and it is also available from meat, poultry, and fish. **Isolated** creatine in supplements eliminates synergistic components of food, producing a more pharmaceutical result. It is thought to build muscle and increase energy, yet "**very little**" evidence supports improvement of short high-intensity exercise or bursts of energy. Athletes may get temporary higher peak power, but there is contradictory evidence regarding strength, working capacity, and continuous or intermittent endurance activities (such as running and cycling). People vary widely in their response; most will **not** receive an exercise benefit. It **won't** help with fat gain, muscle loss, bone fractions, diminished cardiovascular fitness, insulin resistance, or other issues. It's unclear whether any benefits last after taking it for more than a couple of months. Improvements, if they occur, disappear within a week or so after cessation. After a couple of months of use, edema becomes prevalent; weight gain assumed to be muscle can be fluid retention. Other adverse effects include cramping, diarrhea, nausea, gastrointestinal upsets, irregular heartbeat, dehydration, and a skin condition (pigmented purpuric dermatosis). Concerns exist about its effects on the kidneys, especially in older people and people with existing kidney problems. Adverse effects **don't** occur by eating foods containing creatine. **Beta-alanine** (with histidine) is a precursor of carnosine that occurs in high concentrations in skeletal muscle. Increased carnosine may improve short-duration exercise and tactical performance, and reduce neuro-muscular fatigue (particularly in older people). This may help increase the number of repetitions in resistance exercise, generate greater force by the legs, reduce fatigue, and improve body composition. But beta-alanine needs to be combined with other nutrients (as in real food) since by itself it has a more drug-like effect. **Glutamine**, produced primarily in skeletal muscle, transports nitrogen. Injuries increase nitrogen excretion and induce muscle break-down. Glutamine helps to restore nitrogen and increase skeletal muscle repair and synthesis. Isolated glutamine has only small effects. **L-Carnitine** plays a significant role in cellular energy metabolism. Levels decrease with intense short-duration exercise. It is made by the body and found in meat and dairy products. As for isolated carnitine, some studies show improved performance while others do not. Branched chain amino acids (**BCAAs**) are essential amino acids and play multiple roles in protein metabolism, sparing muscle protein breakdown and promoting muscle protein synthesis. They also stimulate protein synthesis in adipose (fat) tissue and the liver as well as induce the pancreas to release insulin, resulting in increased protein synthesis. Increased muscle strength and decreased muscle damage and breakdown result. BCAAs have a positive impact on performance, perceived exertion, optimization of body composition, and recovery. The food **whey** contains approximately 24% BCAAs plus lactose, minerals, and proteins such as alpha-lactalbumin, beta-lactoglobulin, and lactogerrin. [5,6]

Consuming quality **proteins** (especially after exercise) improves muscle protein synthesis, lowers fat mass, and reduces protein breakdown which enhance effects on strength, muscle mass, and bone formation (even in postmenopausal women); it also improves oxygen utilization by muscles in future exercise. Consuming protein before and during exercise is not necessary. Protein loading is not needed; only the first few ounces (30 grams) actually go towards building muscles. Food sources of protein provide needed nutrients and synergists not present in protein isolates or separated amino acids. High-quality food proteins that contain all of the essential amino acids are most beneficial. Milk or quality milk-based protein-carbohydrate supplements can attenuate exercise-induced muscle damage as well as improve muscle strength and exercise performance. **Whey** protein benefits performance, strength, fat loss, and lean body mass. It is digested quicker, out-performs isolated casein or soy protein, and leads to a significant temporary rise in plasma amino acid levels, which increases muscle amino acid availability after exercise for muscle growth and strength. It stimulates blood flow

that increases nutrient delivery to exercised muscles. Whey contains all the essential amino acids (valine, leucine, isoleucine, methionine, lysine, arginine, histidine, phenylalanine, and tryptophan) plus amino acids such as cysteine, aspartic acid, alanine, glutamic acid, glycine, proline, serine, and tyrosine. Cysteine, a sulfur-containing amino acid, is needed for the synthesis of glutathione which is reduced during exercise; it plays a role in lessening damage and speeding recovery from exercise. BCAAs in whey benefit weight loss programs that combine exercise with diet. BCAAs and other amino acids in whey increase muscle mass, increase exercise capacity, decrease hunger, help regulate blood sugar use (preventing exercise-induced hypoglycemia and aiding insulin function), aid fat-burning, attenuate the stress hormone response of exercise, boost thyroid, and protect against declining hormone levels after exercise. They support immune function, growth hormone optimization, normal blood pressure maintenance, and they lower cortisol (stress hormone). Some cortisol during a workout is necessary and helpful for fat loss, but too much can result in muscle loss and inhibition of repair from exercise. While many people are dairy intolerant, whey seems to be handled well by most people. It has low levels of lactose and tends to be digested easily. Bovine **colostrum** with whey helps to increase strength, stamina, and endurance as well as reduce recovery time after exercise. It aids muscle injury healing, promotes bone formation and suppresses bone resorption (countering loss of bone density). However, **too much** protein without other nutritional factors can create an excess renal acid load (causing excess calcium excretion for one thing) and metabolic acidosis. This can adversely affect many areas including bones and muscles. Meats, fish, dairy products (especially cheeses), and grains increase dietary acid load which can be balanced and overcome by consuming sufficient alkaline-producing foods such as fruits and vegetables. A moderately high protein intake along with high fruit and vegetables intake will have an alkaline-increasing effect and the combined nutrients and phytonutrients support bone, connective tissues, nerves, organs and more. [7]

MINERALS. **Zinc**, the second most abundant trace element in the body (nearly 2 grams), is needed for healing tissue damage, for macronutrient metabolism, insulin, thyroid hormones, cell replication, proper immune function, endurance, and more. It is required in over 300 enzymatic pathways. Intense exercise increases need. **Magnesium** has modulatory effects on the immune system and helps muscles to relax. It is needed for protein, carbohydrate, and fat metabolism, and for production of ATP. A magnesium (and often potassium) depletion can contribute to muscle cramping. It is important in bone health; 50 to 65% of body content is in bones. Low **iron** means low energy, fatigue, performance impairment, and less effective workouts. With iron deficiency anemia, not only is exercise capacity decreased but immune function is compromised. Iron is an oxygen carrier in blood hemoglobin and in muscles as myoglobin. It is a crucial part of the electron transport system. Good food sources include liver, beef, oysters, clams, dark poultry meat, legumes, and green leafy vegetables. **Copper** is vital in preventing anemia. Copper, zinc, manganese, and boron are needed to produce strong connective tissues. **Calcium,** magnesium, phosphorus, and vitamin D are among the nutrients needed to build and maintain bone mass. High-protein and high-sodium diets result in urinary losses of calcium as can a lack of vitamin D and other nutrients. Phosphorus intake is often excessive because it is prevalent in processed foods such as soft drinks. High phosphorus-to-calcium ratios contribute to higher fracture rates. Increasing calcium intake from food is more beneficial to bone and connective tissues than isolated calcium which is missing its nutrient coworkers including silica and magnesium for better absorption. **Potassium**, with other minerals such as magnesium and manganese, can curtail muscle cramps. Potassium helps to increase bone mineral density and is needed to maintain electrolyte levels. Deficiency is common because people don't eat enough fruits and vegetables, and because sodium consumption is too high. **Boron** stabilizes and extends the half-life of vitamin D and thus has an indirect effect on bone health. A deficiency of **silicon** is associated with poor skeletal health and initiation of the bone mineral process. Sea **salts** containing trace minerals have electrolytic properties and may help relieve muscle cramps as long as excessive sodium is avoided. [8]

VITAMINS. **B-vitamins** such as thiamin (B_1), riboflavin (B_2), niacin (B_3), and pyridoxine (B_6) are involved in conversion of proteins and carbohydrates into energy. They are used during the production and repair of cells including red blood cells. Thiamin (as thiamin pyrophosphate) plays a key role in protein and carbohydrate metabolism. During exercise, VO_{2max} (maximum oxygen consumption, a measure of exercise capacity) is higher and heart rate is lower in people getting adequate thiamine pyrophosphate compared to those who do not. Riboflavin contributes the flavin portion to coenzymes needed in the electron transport system. With other nutrients it can help to alleviate muscle cramps and reduce neuromuscular irritability. Niacin is part of the coenzymes nicotinamide adenine dinucleotide phosphate and nicotinamide adenine dinucleotide which are

important in carbohydrate and fat metabolism. B_6 in coenzymes pyridoximine 5-phosphate and pyridoxal 5-phosphate is needed in more than 100 biochemical reactions. B_6 helps to break down muscle glycogen to provide glucose. Folate and vitamin B_{12} are vital blood-building nutrients. Active people lacking adequate B vitamins may not perform as well during exercise and have a decreased ability to repair and build muscle. **Choline** can be significantly depleted during long bouts of exercise. Adequate choline intake can compensate for the loss, improve performance, and speed recovery after exercise. **Vitamin C** complex is essential to connective tissue integrity, the immune system, inflammation and repair processes. Raw fruits and vegetables are rich sources. The flavonoid quercetin increases VO_{2max}, performance and endurance capacity. **Vitamin A** is essential to muscle-building and utilization of protein. Vitamin-A rich foods include liver and food-based supplements such as cod liver oil. Adequate **vitamin D** in older adults is associated with improved muscle strength and lowered risk of decline in physical activity compared to those with low levels. Its role in bone health is well known. It enhances intestinal calcium absorption and reabsorption of calcium from kidney tubules as well as affecting osteoclastic activity. Sunshine is the best source. Unrefined cod liver oil and wild salmon are among other sources. **Vitamin K** is associated with bone strength and reducing bone turnover. [9]

OTHERS. Conjugated linoleic acid (**CLA**), a fatty acid found mostly in beef, lamb, and dairy, helps preserve muscle and increase loss of fat when combined with resistance exercise. CLA is produced from linoleic acid and alpha-linolenic acid by bacteria in the gastrointestinal tract. Meat and dairy from grass-fed animals can provide 300—500% more CLA than cattle fed the usual hay, silage, and grain. Some mushrooms also produce a little CLA. **Omega-3** fatty acids boost immune function in the recovery time after exercise. During exercise they improve cardiovascular function, reduce cardiovascular risk factors (such as excessive heart rate and diastolic blood pressure), increase oxygen delivery, and reduce oxygen consumption. They ameliorate delayed onset muscle soreness induced by exercise, improve attention, and reduce reaction time. But separated from their food synergists, they provide few if any benefits. [10] **Alpha-lipoic acid** (ALA) is a coenzyme in cells where it is involved in carbohydrate metabolism and ATP production. It helps to lower excessive blood sugar levels, improve insulin efficiency and sensitivity plus improve glucose uptake into skeletal muscle (by 40 to 300%). It helps protect brain and nerve tissues, increase energy expenditure, spare glutathione (which is reduced with exercise), and may decrease food intake if weight loss is needed. But glutathione blood levels aren't increased by taking isolated ALA; large doses can cause gastrointestinal upsets, diarrhea, insomnia, fatigue, headaches and skin rashes; it lowers B_1 levels and interferes with some medications. Our cells make ALA; red meat, organ meats (like liver), and nutritional yeast are among food sources. [11] **Coenzyme Q10** (CoQ10) participates in production of ATP and drives a number of processes including muscle contraction, protein production, and stabilization of cell membranes. Adequate blood and muscle levels can improve performance, aerobic power and anaerobic threshold. CoQ10 is made in the body and requires B vitamins and other nutrients for synthesis. Food sources include meat, poultry, fish, nuts, fruit, vegetables, eggs, and dairy products. [12]

Many isolated, synthetic, and non-food 'nutrients' have been studied for exercise energy and performance. Some studies find limited improvements but the results are pharmacological, not nutritional, and there are risks of adverse effects. Many other studies show that such drug-like supplementation has no beneficial effects. "Routine consumption of megadoses of vitamins and minerals is not advised," says Michael Gleeson, PhD, School of Sport and Exercise Sciences. [13] Instead, real **food** sources work effectively and safely. For example, **watermelon** juice reduces post-exercise muscle soreness. An amino acid, L-citrulline, is suspected to be the reason, but adding extra L-citrulline provides no extra benefits. It is the synergistic combination of all the food's nutrients that really works. Not only is the amount naturally present sufficient, but it is best absorbed from the unpasteurized watermelon juice. Cashew **apple** juice increased fat oxidation during high-intensity exercise in both trained and untrained subjects. Apples with their polyphenols can attenuate physical fatigue and improve physical performance. Apples contain vitamin C with more components than ascorbic acid; supplements of separated ascorbic acid had no effect on physical fatigue or performance. A **blueberry** smoothie (blueberries, banana, apple juice) aided recovery of exercise-induced muscle damage. Soreness was reduced and muscle peak isometric strength was accelerated. These results are similar to those reported in other studies involving fruit in which an improvement in muscle function was reported. A study with **bananas** found that the fiber, nutrients (such as potassium, vitamin B_6) and natural complex sugars improved performance. Tart **cherries** increase muscle strength and reduce muscle pain. Dark **chocolate** can improve heart health and exercise performance. It reduces the oxygen cost of short- and long-duration moderate intensity exercise, improves

performance and endurance, and increases the gas exchange threshold. Dark chocolate contains abundant flavonols that increase the bioavailability and bioactivity of nitric oxide (NO). This reduces the oxygen cost of exercise, helps to dilate blood vessels, and improves cardiovascular health and blood flow to muscles. It can lower exercise-induced high blood pressure in even overweight people. **Beets** aid exercisers in several ways. One is its **betaine** content that improves muscle endurance, fatigue, and power performance. It increases lean mass, decreases fat mass, and improves some measures of strength and power. Betaine is also found in whole grains and green leafy vegetables. Another beet component is **nitrate**—not nitrate used in processed meats, but nitrate found in raw vegetables such as kale, arugula, collards, other leafy greens, and celery. Beetroot has the highest nitrate concentration. When nitrate-rich vegetables enter the mouth, bacteria on the tongue reduce nitrates to nitrites which is swallowed and then either reduced to nitric oxide (NO) in the acidic environment of the stomach, or absorbed through the small intestine and placed into the blood as nitrites. NO has many health benefits. Most notably, it opens up blood vessels, increasing blood flow and improving circulation. Benefits include a decrease in blood pressure, considerable performance enhancement, improved tolerance to high-intensity exercise, and improvement in "exercise economy"—muscles use less oxygen for the same amount of work used without beets. So a person can exercise longer without reaching exhaustion. Beet greens are a good source of fiber; protein; minerals including copper, iron, potassium, manganese, magnesium and calcium; carotenes (especially beta-carotene and lutein); B vitamins, and vitamins C, E and K. [14]

DIET is a controversial issue. Studies have varied conclusions. Specific dietary regimens and the amount and timing of carbohydrate, fat and protein intake is debated. Timothy Noakes, Professor of Exercise and Sports Science, says, "There is no such thing as a one-size-fits-all plan." Whether one should eat more or less fat, carbohydrate, or protein "is specific to the individual" with "wide variability." Some people tend to be fat burners and others carbohydrate burners; some need more protein while others do well with less. Top athletes tend to choose a diet that optimizes their performance and health. Discovering what individually works best applies to other active people too. Quality is the most important aspect. For weight control, people tend to "underestimate what they eat and overestimate how many calories they burn with exercise." What counts more than calories is the quality of what is ingested. When real healthful food is consumed, appetite is far more satisfied. When refined, over-processed, low-nutrient items are consumed, appetite is increased because the body isn't getting what it needs and signals for more. But not eating enough, thinking all food is fattening and eating will undo exercise benefits, is also unbalancing. Proper (clean water) **hydration** is vital to performance and health. [15]

Carbohydrates are our major source of energy in the form of glucose in the blood and glycogen (storage form) in the muscles and liver, and are used more efficiently than proteins or fats. Nutrient-dense complex carbs keep muscles filled with high-intensity energy from ATP, creatine phosphate and glycogen. Carbs should be consumed before any prolonged activity, but "carb-loading" regimens are no longer recommended. There is a "carbohydrate tipping point" beyond which there ceases to be a performance advantage. Years ago, the advice was not to eat carbs before exercising due to a boost in insulin levels which results in a drop in blood sugar and impaired performance. But insulin levels go back down when you start to exercise. Studies find that eating carbs shortly before exercise improves performance or has no effect on it. It depends on what the individual is doing, what was eaten earlier, and **if** anything is eaten while exercising. Some carbs are metabolized and oxidized differently than others. Refined sugars are burned at a higher rate. A high-sugar meal or drink after working out will stop the benefits of exercise-induced human growth hormone. You may still burn calories but miss the enhanced fat burning afterwards. [16] **Fats** are required for absorption of fat-soluble vitamins (A, D, E and K) and for long-term energy. Fat stores provide energy when blood glucose levels from carbs decline. Extra dietary carbs and fats are converted into stored fat, so excessive fat is unnecessary. The types of fats consumed should include unsaturated fatty acids (such as monounsaturated, omega-6 and omega-3 fats), and saturated fatty acids (such as medium-chain and long-chain). The amount needed for each type varies with the individual. Polyunsaturated fats influence the immune system and inflammatory responses. Medium-chain saturated fats are oxidized faster than long-chain saturated fats, providing a quicker energy source and possibly inhibiting fat storage. Athletes need greater fat intake, but for other active individuals, high-fat diets are of no benefit to performance or health, can be difficult to follow and can cause gastrointestinal distress. [16] **Proteins** provide amino acids needed for synthesis and repair of skeletal muscle, oxygen-transport, metabolic- and energy-production hormones and enzymes. Inadequate protein lowers immune resistance and affects stamina and energy. Athletes need more protein than other people, but for the average active person, loading

protein is not needed and the amount needed is individualized (older adults may need slightly more than younger ones). Consuming some protein shortly *after* exercise may boost muscle synthesis. Quality proteins increase lean muscle and keep hunger at bay (if weight loss is a goal). Whey protein is especially helpful in that area. [15] Fasting before exercise has little or no effect on fat burning. Some people burn more fat when they eat something before exercising than when they fast. Fasting before intense or prolonged exercise impairs performance and reduces energy; eating carb snacks or beverages during the exercise is advised; otherwise stored carbs are depleted resulting in weakness, fatigue, and/or pain—"hitting the wall." Most active people do not engage in hours of prolonged exercise and don't need to eat during the activity. Exercising moderately for less than an hour only requires drinking water when thirsty. "**Clean**" eating should be the goal—avoiding over-processed or refined foods, and any other nonfoods (items that have little or no true nutritional value). [15] Active people need to consume real foods and real-food supplements, not isolated, synthetic, non-food fabrications.

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