VITAMINS & MINERALS
too much of a good thing?

Text: Riëtte Steinberg Registered Dietitian (SA) PVM Nutritional Sciences (Proteins. Vitamins. Minerals)

Vitamins and minerals are essential for many metabolic processes in the body and are important in supporting growth and development. They are required for reactions involved with physical activity and exercise, such as muscle contraction, energy expenditure, carbohydrate, protein and fat metabolism, oxygen transfer and delivery as well as tissue repair.
Some vitamins act as antioxidants, buffering free radicals produced by increased energy turnover.
Many athletes supplement their diet with extra vitamins and minerals, desiring to improve health, enhance recovery, improve sport performance and prevent infectious diseases. They have reported the use of B-complex vitamins, vitamin E, iron and especially vitamin C.

But is supplementation really necessary?

Studies have demonstrated an increase in **reactive oxygen species (ROS)** with moderate to high intensity exercise. Energy production involves reduction of oxygen in the mitochondria (energy producing part of the cell), during which some of the oxygen turns into free radicals. Free radicals are unstable, reactive and potentially harmful substances. Excessive production, or failure to protect against free radicals, has been linked to cell and mitochondria membrane damage, decreased immunity and other adverse health effects. Antioxidants such as vitamin C and E build up a protection system against free radical attack, thus an increased need may arise. Some minerals may be lost through sweat such as magnesium and zinc, while others may be lost in urine.
Generally, if energy intake is sufficient, varied and balanced and the athlete has a healthy nutritional status, vitamin and mineral supplementation is not warranted. Increased requirements are however subject to the intensity, duration, and frequency of the applicable event/sport. Supplementation is also dependant on the nutritional status of the athlete. Some athletes with a poor nutritional status or impaired dietary intake might benefit from supplementation. For athletes that restrict energy intake, such as in sports with weight restrictions or those that limit certain foods/food groups, supplementation may also be warranted.

Can micronutrient supplements be harmful?

Some athletes supplement micronutrients "just in case". Toxicity however, can arise when daily doses rise above a certain threshold limit. Megadoses of several vitamins may be pathological, particularly vitamin A, D, niacin and B6.
Natural antioxidants like vitamin C and E, caretenoids and polyphenols like flavonoids have many health benefits, including protective effects against cardiovascular disease, certain forms of cancer, and photosensitivity diseases. When supplementing with high doses, beneficial antioxidants can become harmful pro-oxidants. A pro-oxidant is a compound that induces oxidative stress and inhibits antioxidant systems. Thus, rather than protecting against damage, these substances cause damage. The pro-oxidant action of antioxidants includes:

- Vitamin C in high doses causes cell death, and DNA damage
- Vitamin E in high doses causes increased α-tocopherol radicals which can initiate lipid peroxidation (damage to lipid cell membranes)
- Flavanoids in high doses can form radicals instead of scavenging them and also cause lipid peroxidation

Other than harmful pro-oxidant effects, reductions in vascular function have also been noted with administration of mixed antioxidants. Acute doses of vitamin C and E demonstrated reduced brachial artery vasodilatation which reduces exercise capacity and performance.

Vitamin C is known to remove free radicals produced by exercise, thereby reducing the potential

negative consequences of **ROS** such as muscle damage, immune dysfunction and fatigue. **ROS is not all bad though**. Moderate **ROS** production causes physiological changes such as increases in mitochondrial growth factors and cell survival proteins, reductions in muscle atrophy and proteins involved in cell signaling pathways and amplifications of immune function. Moderate **ROS** concentrations are further required for optimal training adaptation and muscle function. Supplementation of vitamin C in doses exceeding 1 g/d has been shown to attenuate the exercise derived rise in **ROS** and blocks cell signaling. Vitamin C in doses of >1g/d thus appear to reduce training induced adaptations by reducing mitochondrial biogenesis or by possible vascular function alteration, and is not recommended.

Toxicity of minerals is relatively rare. The levels associated with toxicity can normally be obtained only through the use of supplements or fortified foods. Intakes needed to reach toxicity levels are high, but when toxic symptoms do appear, they can be fatal. Most multi-vitamin supplements contain minerals close to RDA levels or less, but when athletes self-prescribe, toxicity can become a concern. All trace minerals are toxic when consumed at high doses for a long period of time. Even though toxicity levels are high, certain nutrient interactions can occur with high mineral intake. High intakes of one mineral might interfere with the absorption of another, causing a deficiency. For this reason, precautionary use of mineral supplements should not exceed 5x the recommended intake.

Table 1: Adverse effects of some micronutrients:

	RDA (recommended intake), UL (Upper limit)	Major food sources	Major functions in the body	Symptoms of excessive consumption
Vitamin A	RDA: 900 RAE UL: 3 mg/d	Liver, whole milk, cheese, carrots, green leafy vegetables, sweet potatoes	Promotes bone development, night vision, maintain skin & mucous membranes	Nausea, headache, fatigue, liver and spleen damage, skin peeling, joint pain
Vitamin C	RDA 90mg/d UL: 2000mg/d	Citrus fruits, green leafy vegetables, broccoli, peppers, strawberries, potatoes	Forms collagen essential for connective tissue development, aids in iron absorption, antioxidant	Diarrhea, possible kidney stones, rebound scurvy
Vitamin E	RDA: 150mcg/d UL: 1000mg/d	Vegetable oils, margarine, green leafy vegetables, whole grains, egg yolks.	Antioxidant,	Headache, fatigue, diarrhea
Vitamin B6	RDA: 1.3mg/d UL: 100mg/d	Liver, lean meats, fish, poultry, legumes, green leafy vegetables, baked potatoes, bananas	Coenzyme in protein metabolism, formation of hemoglobin and red blood cells, needed for glycolysis and gluconeogenesis	Loss of nerve sensation, impaired gait
Vitamin B3	RDA: 16mg/d UL:35mg/d	Lean meat, fish, poultry, whole grains, beans	Coenzyme for aerobic and anaerobic production of energy, fat synthesis, healthy skin	Headache, nausea, burning and itching skin, flushing of the face, liver damage.
Calcium	RDA:1000mg/d UL: 2500mg/d	Dairy products, dried beans and peas, dark green leafy vegetables.	Bone formation, enzyme activation , nerve impulse transmission, muscle contraction	Constipation , inhibition of trace mineral absorption , heart arrhythmias, kidney stones
Magnesium	RDA: 420mg/d UL: 350mg/d from supplements	Milk and yoghurt, dried beans, nuts, whole grains, fruit and vegetables	Protein synthesis, glucose metabolism , smooth muscle contraction, bone component.	Nausea, vomiting, diarrhea.
Iron	RDA: 8mg/d UL: 40mg/d	Liver, meat, fish, poultry, dried beans and peas, whole grains, spinach, broccoli	Hemoglobin and myoglobin formation, electron transfer, oxidative process	Hemochromatosis, liver damage
Zinc	RDA: 11mg/d	Organ meats, meat, fish, poultry, dairy products, nuts, whole grains, vegetables, spinach, asparagus	Cofactor of many enzymes involved in energy metabolism, protein synthesis, immune function, sensations of taste, smell	Increased LDL and decreased HDL cholesterol, impaired immune system, nausea, vomiting, impaired copper absorption.

**Take note: the above mentioned recommendations differ for various age and gender groups.*

What intake level is considered safe?

Because more and more foods are being fortified these days, reaching total requirements is not that hard and the risk of over-supplementing when taking extra micronutrients is high.

- The upper limit (UL) is the maximum quantity of a nutrient most individuals can consume without resultant adverse effects.
- It is recommended that any precautionary use of supplements should remain within the recommended intake ranges.
- Because of increased oxidative stress, a "normal dose" of 60-90mg/d vitamin C may not be appropriate for athletes. Reviewers found that a dose of 0.2-1g/d will reduce oxidative stress by the needed modest margin. In one study, a dose of 500mg/d vitamin C, did not reduce exercise induced blood flow – this dose is thus considered to be safe.
- It is recommended that intake should come from five servings of fruit and vegetables due to other health benefits provided by these foods. Fruit and vegetable intake may be associated with lower cancer risk not because of vitamin C alone, but because of the interactions with other bioactive compounds and phytochemicals.
- Studies support the notion that vitamin C in isolation is not enough. During times of acute stress, intakes of >0.2 but less than 1g/d may benefit athletes (such as acute onset of illness or during training camps).

Because every athlete differs, current nutritional status, energy and nutrient intake have to be assessed and individual requirements should be determined. A registered dietitian with expertise in sport nutrition should be consulted to establish an athlete's individual nutrition and performance goals.

"When talented, motivated and highly trained athletes meet for competition the margin between victory and defeat is usually small. When everything else is equal, nutrition can make the difference between winning and losing" – Maughan (2002).

Alfred Rheeder - PVM Nutritional Sciences. Should you require nutritional assistance contact PVM at (012) 804 7676 or visit www.pvm.co.za

PVM Nutritional Sciences offers superior nutrition through applied science. Since 1968 PVM, the producer of the worlds original energy bar, has remained dedicated to a cutting edge understanding of the biology of energy exchanges between humans and their environment. PVM is involved with numerous top athletes and sport teams and is also subcontracted to condition the Free State Cheetahs.

Smart Foods®

POWERED BY PVM NUTRITIONAL SCIENCES®©

Ethics in Nutrition©