



## The Many Faces of Magnesium: The Secret Agent of Health

Magnesium is one of those supplements that is very well known for its benefits throughout the natural health community. However, one of the problems with magnesium's almost celebrity status is that the details of the multiple benefits that it has to offer are often overlooked and underappreciated. This article explores the key role that magnesium plays in a number of disease processes. Additionally, it will highlight the benefits of certain often overlooked magnesium compounds (chelates), which complement magnesium by exerting their own beneficial effects.

### **Magnesium is Vital**

Magnesium is involved in over 300 biochemical processes in the body. One of its most important functions is that it plays a key role in producing energy (see Figure 1). This makes it vitally important for all cellular functions and processes. It helps maintain normal muscle and nerve function, keeps heart rhythm regular, supports a healthy immune system, and keeps bones strong. The problem with this essential mineral is that most people do not have sufficient levels for optimal health.

A gradual depletion of nutrients from our soils has left many vegetables with lower levels of magnesium. Despite eating a healthy and well-balanced diet, a person can develop low magnesium levels over time. A dietary survey suggests that many North Americans do not get the minimum recommended amounts of magnesium daily.<sup>1</sup> Even though

the classic symptoms of magnesium deficiency are rare, health issues can occur well before an overt deficiency. A good analogy is a rusty versus well-oiled wheel. A constant low level of magnesium will still allow the rusty wheel to turn but it will be slower and require greater effort. The same can be said about cellular energy production if magnesium levels are below optimum levels.

### **Causes of Magnesium Deficiency**

Another factor that contributes to magnesium deficiency is that it is often depleted by various common conditions and medications. Since magnesium is absorbed in the small intestine, conditions such as Crohn's disease, intestinal surgery, gluten sensitivity (celiac enteropathy)<sup>2</sup> and other health problems can impair absorption. Frequent diarrhea and vomiting can also cause depletion. Irritable bowel syndrome is the most common disorder diagnosed in North America and it can often cause loose stools and intestinal spasms, which can contribute to further magnesium excretion in addition to impairing absorption.

Many commonly used medications, such as proton pump inhibitors, diuretics and antibiotics cause magnesium depletion.<sup>3,4</sup> Some of these drugs are taken for a long time, which can create a deficiency over that time. This is especially concerning when many elderly are on multiple medications for a number of years. Older adults are at an increased risk for magnesium deficiency since intestinal absorption of most

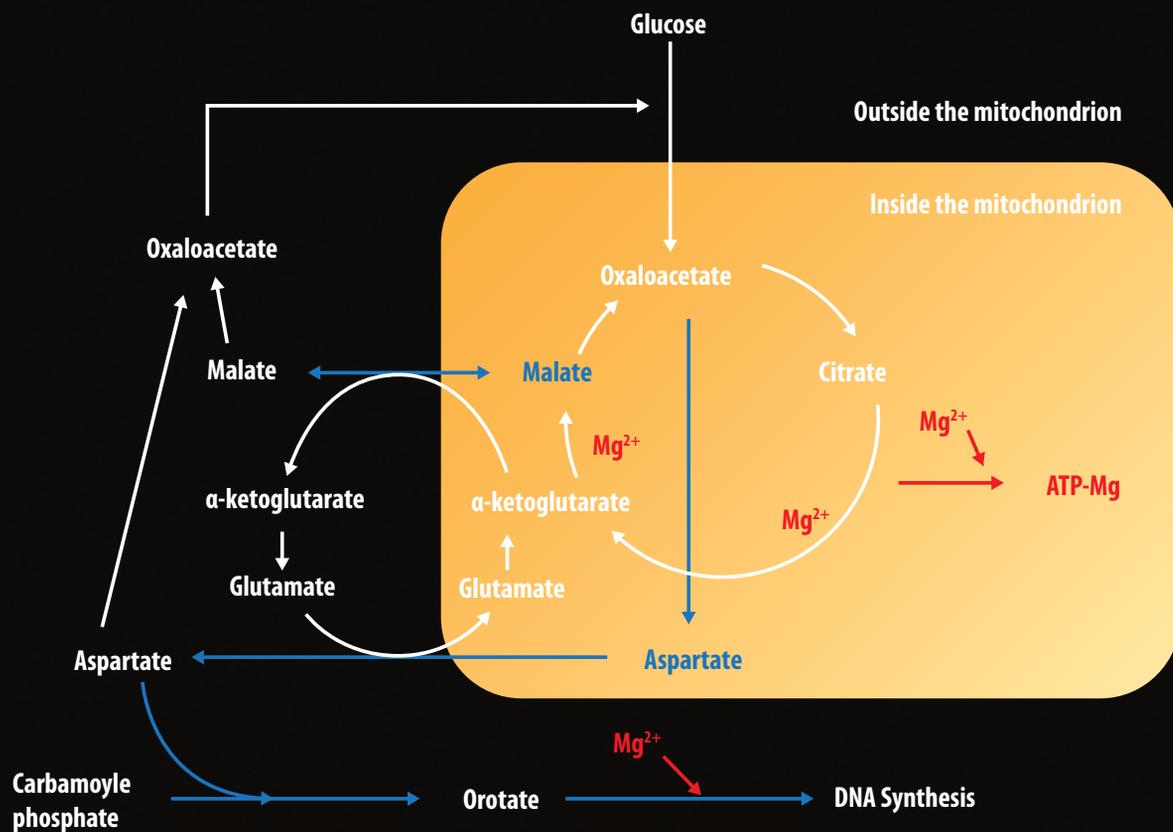


Figure 1. The Role of Magnesium, Malate, Aspartate & Orotate in Energy Production and DNA Synthesis

nutrients can decrease with age. They also have lower intakes than younger adults and often have increased excretion.<sup>1</sup> The combination of a diet with low amounts of magnesium, poor intestinal absorption due to intestinal damage and prescription drug use can all contribute to chronically low magnesium levels.

#### Low Magnesium Levels Linked to Poor Health

Considering the pivotal role that magnesium plays in cellular signaling, function and energy production, it is no surprise that a deficiency has a broad impact on multiple organ systems and has been linked to numerous health conditions. Additionally, supplementing with magnesium has also been shown to have positive results in a number of pathologies. The following is a selected list of key conditions that magnesium has been studied to have a beneficial effect on.

**Cardiovascular disease:** A recent review found a significant inverse correlation between serum magnesium and incidence of cardiovascular diseases.<sup>5</sup> Low magnesium levels have been implicated in inflammation and endothelial dysfunction. This proinflammatory state is believed to disrupt the arterial lining and promote thrombosis, which leads to atheroma formation and atherosclerosis, hypertension, and vascular calcification.<sup>5</sup> Furthermore, magnesium also inhibits HMGCoA reductase, the rate-limiting enzyme for cholesterol synthesis (much like the statin class of drugs). Therefore it can reduce low-density lipoprotein (LDL).<sup>6</sup>

**Hypertension:** Magnesium causes vascular smooth-muscle cell relaxation by acting as a mild calcium blocker and reduces angiotensin-induced aldosterone synthesis, which

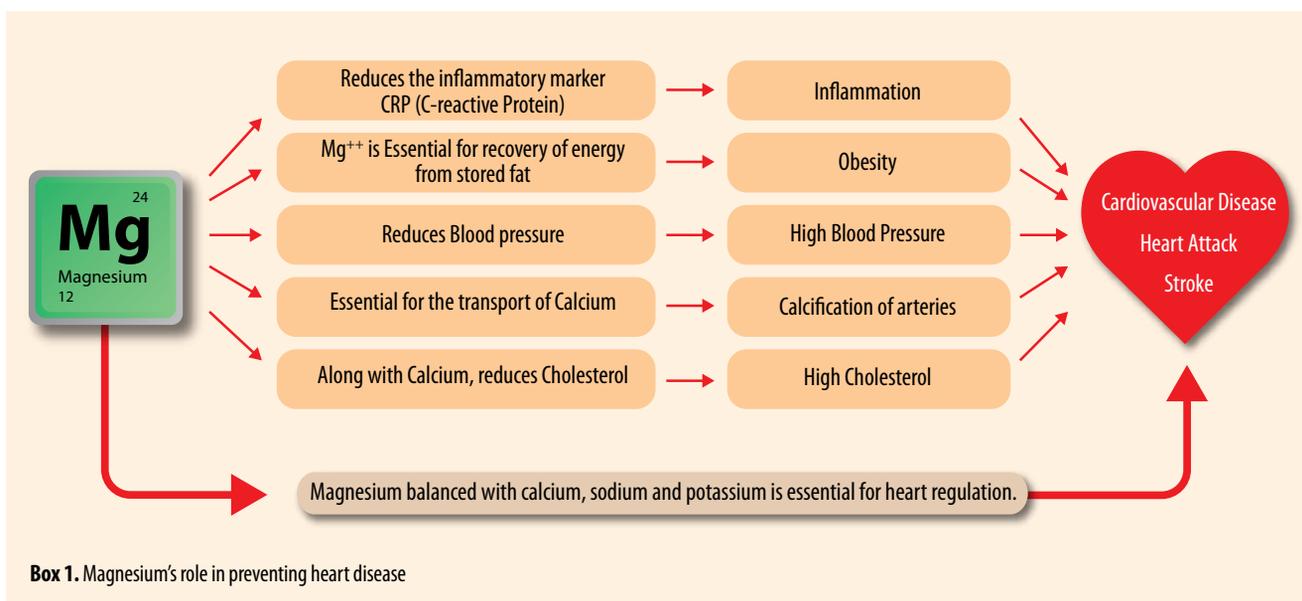
can lower blood pressure.<sup>5</sup> A recent meta-analysis found that magnesium supplementation showed an average decrease in systolic blood pressure of 3-4 mmHg and diastolic of 2-3 mmHg.<sup>7</sup> Additionally, people taking diuretic medications for hypertension can have higher magnesium excretion, so they have an additional need for supplementation.

**Diabetes:** Magnesium is commonly deficient in many type 2 diabetics due to loss through the urine. Low intracellular magnesium has been linked to impaired insulin action, insulin resistance and inflammation.<sup>8</sup> Considering the importance of magnesium in hypertension, low magnesium levels are most likely a key factor in metabolic syndrome as well. Since diabetics are at a higher risk of cardiovascular disease and magnesium is essential for the proper function of insulin, they have a greater need for adequate magnesium levels.

Other disease processes linked to improvements with magnesium supplementation include atrial fibrillation, cardiac arrhythmia, osteoporosis, kidney stone prevention, chronic pain, stroke recovery, fibromyalgia, chronic fatigue syndrome, headaches, ADHD, asthma, non-alcoholic steatohepatitis (NASH), premenstrual syndrome and menstrual cramps to name a few. Interestingly, magnesium is also required for the conversion of the active form of vitamin D. A deficiency of magnesium can impair the production of vitamin D which like magnesium has a myriad of health benefits.

#### Choosing Among Magnesium Supplements

As a supplement, magnesium is most commonly found in



small amounts in multivitamins and in certain over the counter laxatives. Minerals such as magnesium or calcium are combined with another molecule to stabilize the compound. Each combination (such as magnesium citrate) has different absorption, bioavailability and therapeutic value. These additional molecules can really impact the medicinal value of the magnesium, and some even have beneficial effects in their own right.

There are a number of different forms of magnesium available on the market. The most common forms and their benefits are listed below.

**Magnesium oxide:** Often used in milk of magnesia products since this form has a strong laxative effect. Even though this combination contains a large proportion of magnesium compared to the oxide molecule, it has poor bioavailability and readily causes loose stools, therefore it is considered the least optimal form to use as a supplement.

**Magnesium sulfate:** This form is often used as an intravenous preparation but it is not used in oral formulations. Since it does have some absorbability through the skin, it is also found in Epsom bath salts.

**Magnesium citrate:** A commonly used form that has good bioavailability compared to oxide. It is also very rapidly absorbed in the digestive tract

but it does have a stool-loosening effect.<sup>10</sup> This form is found in many supplements and remains a solid option for delivering magnesium into the body.

**Magnesium aspartate:** This form has increased bioavailability compared to oxide and citrate. There were some promising clinical trials conducted in the 1960s that found a combination of magnesium and potassium aspartates had a positive effect on fatigue and they reduced muscle hyper-excitability.<sup>11</sup> Physiologically this makes sense since both magnesium and aspartic acid are critical players in cellular energy production. This form is not commonly found but has been used for chronic fatigue syndrome.

**Magnesium glycinate:** Glycine is a well known calming amino acid. This combination has good bioavailability and it does not have a laxative effect since glycine is actively transported through the intestinal wall. Due to the calming and relaxing effect of both glycine and magnesium, this combination has been used successfully for chronic pain and muscle hypertonicity.<sup>12</sup>

**Magnesium malate:** This little-known combination has been studied for use in fibromyalgia. Since malate is a substrate in the cellular energy cycle, it can help improve ATP production, and there is some preliminary evidence that it may

reduce muscle pain and tender points in fibromyalgia patients.<sup>13</sup>

**Magnesium orotate:** This is another relatively unknown chelate combination containing orotic acid. This form has good bioavailability has had been studied specifically for heart health. Orotates can penetrate cell membranes, enabling the effective delivery of the magnesium ion to the innermost layers of the cellular mitochondria and nucleus. Orotates themselves increase the formation of RNA and DNA which can help heart cells repair and therefore improve function. The combination has been shown to improve heart failure, symptoms of angina and exercise performance in clinical trials.<sup>14,15</sup>

**Magnesium taurate:** Both magnesium and the amino acid taurine share the ability to improve cardiac function, both have a potentiating effect on insulin sensitivity and both have calming effects on neuromuscular excitability. The actions of both have striking similarities when it comes to cardiovascular health. They both have blood pressure reducing effects, stabilize nerve cells, improve the contraction of the heart muscle and have an anti-thrombotic effect.<sup>16</sup> Additionally, low levels of vitamin B6 have been shown to further deplete both magnesium and taurine.

**A note on potassium:** When there is a magnesium deficiency there often can

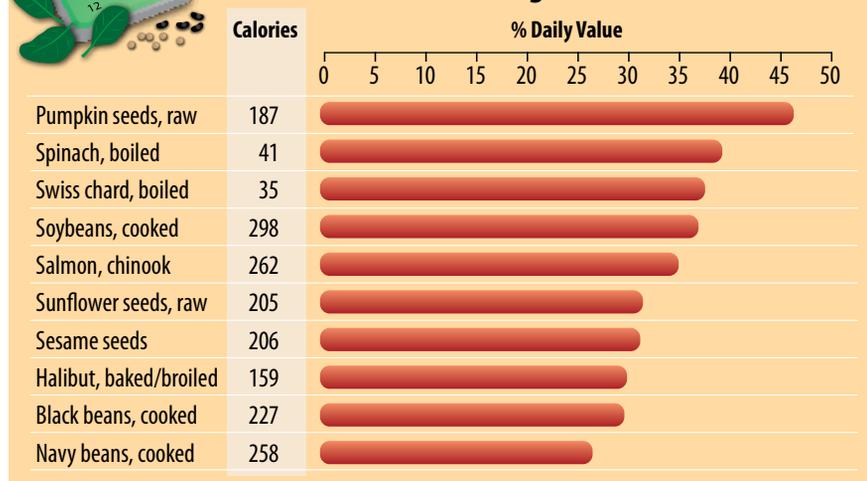
be a concurrent potassium deficiency. A major function of potassium is to maintain the excitability of nerve and muscle tissue; together with magnesium it plays a key role in maintaining a stable and regular heart rhythm and muscle contraction. Both of these key minerals can become deficient in chronic alcoholism, diabetes (type 2), severe vomiting and diarrhea and with the use of diuretic drugs.<sup>17</sup> Therefore, if there is a magnesium deficiency present, consider potassium levels as well.

### Concluding Thoughts on Magnesium

Due to its broad ranging beneficial effects, magnesium has really emerged as a quintessential health supplement with an excellent safety profile. Very few natural ingredients have such a large body of compelling evidence for their use. As with vitamin D, it would be prudent to assess your intracellular levels to address any deficiency that may be present. Our diet and lifestyle unfortunately predispose many people to developing an insidious



### Foods rich in Magnesium



**Box 2.** Healthy food sources of Magnesium

deficiency of this essential mineral. Many health conditions can benefit from magnesium supplementation to restore optimal cellular function and energy production. Various forms of magnesium can be employed for specific health concerns and to

increase bioavailability. Even though magnesium can often get overlooked for more vogue or popular supplements, the overwhelming benefits speak for themselves, thus making it a “not-so-secret agent” in your quest for optimal health. ■

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