

# Magnesium



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Magnesium is an essential mineral that serves as an enzyme cofactor for over three hundred biochemical reactions in the body, including those of glycolysis, the first step in harnessing energy from carbohydrates.<sup>1</sup> Magnesium follows potassium as the second most abundant intracellular cation (positively charged electrolyte) in the body.<sup>2</sup> The adult human body contains approximately 25 grams of magnesium, over 60% of which is found in the skeleton. Muscle tissue contains about 27%, with the bulk of the balance found in other intracellular areas, and less than 1% occurring in the blood.<sup>3</sup>

As a structural component of the hydroxyapatite mineral matrix of bone, a natural calcium channel blocker, muscle relaxant, facilitator of calming effects upon the nervous system, and a required element for electrolyte balance and proper functioning of sodium-potassium pumps, magnesium plays a crucial role in supporting physical strength and mobility, muscle contraction, neurological health, cardiac function, and psychological balance. Magnesium's role as an enzyme cofactor for processes that generate ATP underlies its importance for maintaining energy levels and metabolic efficiency.

## BENEFITS

- **Bone health:** The practice of supplementing solely with calcium, in the absence of required vitamin and mineral cofactors, may not have the intended effect of reversing or preventing bone loss. Magnesium is an essential element of the physical structure of bone tissue and helps contribute to maintaining healthy bones.
- **Compromised digestion:** Patients with compromised digestive function—such as those who have been on long-term proton pump inhibitors (PPIs) or other stomach acid-reducing drugs—may benefit from extra magnesium, as hypochlorhydria may prevent adequate liberation of minerals from their food bases, including magnesium. Continued use of PPIs may inhibit proper absorption of oral magnesium.<sup>7-9</sup> Long-term use of acid blockers is increasingly linked to low mineral status, as well as bone fractures.
- **Cardiovascular function:** Owing to its role in muscle contraction and relaxation, and nerve conduction, magnesium may help support healthy cardiovascular function and blood pressure levels. Hypomagnesemia is associated with cardiac arrhythmias, ischemic heart disease, sudden cardiac death, hypertension, transient ischemic attacks (TIA), stroke, and pre-eclampsia.<sup>10,11</sup> Moreover, magnesium is a cofactor for the desaturase enzymes involved in synthesizing anti-inflammatory and vasodilating prostaglandins (PGE1). As such, it has been shown to reduce blood pressure in hypertensive patients, with those having the highest blood pressure exhibiting the most favorable and significant responses. The effect is even greater when magnesium is combined with potassium, and when sodium levels are lowered. Additionally, magnesium supplementation may have an additive effect when combined with hypertensive drugs, contributing to an even greater reduction in blood pressure.<sup>12</sup>
- **Diabetes & insulin resistance:** Research supports that magnesium deficiency is associated with, and may exacerbate, insulin resistance and diabetes. Magnesium plays a key role in insulin-mediated glucose uptake. Reduced intracellular magnesium concentration results in lower activity of the tyrosine-kinase enzyme required for proper functioning of the insulin receptor, which may contribute to insulin resistance. Many studies have demonstrated positive effects on the metabolic profile of type-2 diabetics supplementing with magnesium.<sup>13,14</sup>
- **Chronic headaches:** Migraine headaches and milder forms of headaches have long been known to respond to magnesium supplementation. Patients experiencing active migraines show rapid and significant relief upon intravenous magnesium infusion. For more practical long-term treatment, regular oral supplementation has also been shown to reduce the frequency of migraines.<sup>15,16</sup>
- **Bowel function/chronic constipation:** Magnesium draws water into the lower GI tract, making stools softer and easier to pass. This property underlies the traditional use of Epsom salt (magnesium sulfate) as a saline laxative. Magnesium citrate has been employed in pre-colonoscopy emptying of the colon, with fewer unpleasant side-effects and better patient tolerance than the more common polyethylene glycol preparations.<sup>17</sup>
- **Kidney stones:** The delicate balance between calcium and magnesium suggests that adequate magnesium levels may protect against inappropriate deposition of calcium in the soft tissue. Low magnesium levels are common in patients prone to developing kidney stones. Increased urinary magnesium concentrations have been shown to reduce the formation, and decrease the size, of calcium oxalate crystals, possibly by forming soluble complexes with oxalate. Magnesium may also reduce absorption of oxalates by binding exogenous oxalate in the intestine.<sup>18,19</sup>

## VARIOUS FORMS OF MAGNESIUM

### **MAGNESIUM BISGLYCINATE CHELATE (Magnesium Chelate Powder & Tablets, Magnesium Buffered Chelate):**

A highly absorbable form of elemental magnesium chelated to two molecules of the amino acid glycine. The amino acid chelate is absorbed via dipeptide channels, bypassing the usual active transport and passive diffusion routes for intestinal ion absorption, where magnesium would otherwise compete with other minerals. This method of delivery allows larger amounts of magnesium to be absorbed more quickly and be better retained by the body, as compared to many other forms.<sup>20</sup> Moreover, the breaking of the bonds between magnesium and glycine allows the body to use both the mineral and the amino acids, making this a more physiologically natural and nutritionally beneficial process than other chelated mineral delivery mechanisms, such as EDTA. The magnesium-glycine complex protects magnesium from binding to dietary phytates and tannins, therefore enhancing its bioavailability.<sup>20</sup> This unique form of magnesium has been shown to be effective for individuals with the greatest impairments in magnesium absorption, including those with inflammatory bowel conditions, among whom the prevalence of overt magnesium deficiency may be as high as 86%.<sup>21</sup> Compared to healthy subjects, those with compromised intestinal mineral absorption excrete twice as much magnesium when given in insoluble salt form (such as Mg oxide), as opposed to a chelate. This amino acid chelate may be especially beneficial for those who require high doses of magnesium, as relatively high doses lead to fewer unwanted gastrointestinal effects that may present with other forms of supplementation. Chelated magnesium has been shown to reduce the pain associated with dysmenorrhea and the frequency and severity of leg cramps in pregnant women.<sup>22,23</sup>

**MAGNESIUM MALATE (Magnesium Malate):** A highly bioavailable form of magnesium bound to malic acid. Malic acid is a compound found naturally in fruits and vegetables, and is responsible for the tart flavor of rhubarb and green apples. Malate is an intermediary of the ATP-generating Krebs cycle, so it may help support adequate energy levels. As a result, high-dose magnesium malate has been used successfully to improve symptoms of fibromyalgia.<sup>25</sup>

**MAGNESIUM CITRATE (MagCitrato Powder) :** A soluble organic salt form of magnesium that helps promote bowel relaxation. It also supports the ability to fall asleep, and may be combined with inositol or taurine to help promote a restful night's sleep, with less waking during the night. Magnesium citrate exhibits greater bioavailability than inorganic and insoluble forms of the mineral.<sup>24</sup>

**MAGNESIUM THREONATE (NeuroMag™):** A form of magnesium chelated to threonic acid, a metabolite of vitamin C. It is superior to other forms of magnesium at getting through the blood brain barrier because it is able to transport magnesium ions across lipid membranes, including those of brain cells. Compared to other forms, this compound is especially effective at increasing magnesium levels in cerebrospinal fluid. Animal models employing magnesium threonate have demonstrated the compound's promise in protecting neural plasticity in the brain and supporting synaptic density, which may contribute to better cognitive function and enhanced memory. Therefore, this magnesium chelate may be beneficial for age-related cognitive decline.<sup>26</sup> It has also been shown to protect against reductions in short-term memory associated with neuropathic pain.<sup>27</sup>

**MAGNESIUM CHLORIDE (MagneGel™ Transdermal Gel):** A soluble inorganic salt form of magnesium that is effective when applied topically and absorbed cutaneously. Aside from contributing to total body magnesium absorption, topical magnesium may directly improve the condition of the skin it is applied to. Transdermal magnesium has been shown to aid inflammatory skin conditions such as psoriasis, atopic dermatitis, and chronically dry skin. Compared to placebo, soaking in a magnesium chloride-rich solution resulted in reductions in transepidermal water loss, leading to better skin hydration and reduced roughness in patients with atopic dry skin.<sup>28</sup>

*For a list of references cited in this document, please visit <http://mkt.s.designsforhealth.com/techsheets/MagnesiumReferences.pdf>*

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