



## Low Magnesium May Play Key Role in Insulin Resistance and Diabetes

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### Story at-a-glance

- ▶ Magnesium plays a key role in preventing insulin dysregulation and type 2 diabetes, according to several recent studies—yet 80 percent of Americans are likely magnesium deficient
- ▶ One study found those with the highest magnesium intake reduced their risk of metabolic problems by 71 percent
- ▶ Another study concluded magnesium is highly protective for those at high risk for type 2 diabetes
- ▶ Inadequate magnesium intake creates a vicious cycle of low magnesium levels in your body, elevated insulin and blood glucose levels, and excess loss of magnesium in your urine
- ▶ The best source of magnesium is whole, organic foods, especially dark green leafy vegetables; other good sources include seaweed, dried pumpkin seeds, unsweetened cocoa, flaxseed, almond butter, and whey
- ▶ Of the many forms of magnesium supplements available today, a newer form called magnesium threonate shows particular promise due to its ability to penetrate cell membranes, even those in your brain

### By Dr. Mercola

Magnesium is the fourth most abundant mineral in your body. If you don't have enough of it, your body simply cannot function at its best. Insufficient cellular magnesium levels set the stage for deterioration of proper metabolic function that typically snowballs into more significant health problems.

As reported by GreenMedInfo,<sup>1</sup> researchers have now detected 3,751 magnesium-binding sites on human proteins, reflecting how important this mineral is to a great many biological processes.

For example, magnesium plays a role in your body's detoxification processes and therefore is important for minimizing damage from environmental chemicals, heavy metals, and other toxins.

Even [glutathione](#), considered by many to be your body's most powerful antioxidant, requires magnesium in order to be produced.

Magnesium also plays roles in preventing migraine headaches, cardiovascular disease (including high blood pressure, [heart attacks](#), and strokes), [sudden cardiac death](#), and even reduces [death](#) from all causes.

This important mineral is required by more than 300 different enzymes in your body, which play important roles in the following biochemical processes, many of which are crucial for proper metabolic function:

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Creation of ATP (adenosine triphosphate), the energy molecules of your body

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Proper formation of bones and teeth

Relaxation of blood vessels

Action of your heart muscle

Promotion of proper bowel function

Regulation of blood sugar levels

## Low Magnesium Levels Consistently Found in Those with Elevated Insulin

In just the past year, there have been several significant studies about magnesium's role in keeping your metabolism running like a well-oiled clock—specifically in terms of insulin sensitivity, glucose regulation, and protection from type 2 diabetes. Here are just a few:

- One 2013 study involving pre-diabetics found that most had inadequate magnesium intake. Those with the highest magnesium intake reduced their risk for blood sugar and metabolic problems by a whopping 71 percent.<sup>2</sup>
- An ADA study from October 2013<sup>3</sup> found that higher magnesium intake reduces risk of impaired glucose and insulin metabolism and slows progression from pre-diabetes to diabetes in middle-aged Americans. Researchers stated, "Magnesium intake may be particularly beneficial in offsetting your risk of developing diabetes, if you are high risk."
- In a large Japanese study (the Hisayama Study) published in *Diabetic Medicine* December 2013, researchers found magnesium intake was a significant protective factor against type 2 diabetes in the general Japanese population, especially among those "with insulin resistance, low-grade inflammation and a drinking habit."<sup>4</sup>
- And in the Framingham Offspring cohort (2006), higher magnesium intake improved insulin sensitivity and reduced type 2 diabetes risk.<sup>5</sup>

## Why Is Magnesium So Critical for Proper Metabolic Function?

The mechanism by which magnesium controls glucose and insulin homeostasis appears to involve two genes responsible for magnesium homeostasis.<sup>6</sup> Magnesium is also required to activate tyrosine kinase, an enzyme that functions as an "on" or "off" switch in many cellular functions and is required for the proper function of your insulin receptors.

It is well known that people with insulin resistance also experience increased excretion of magnesium in their urine, which further contributes to diminished magnesium levels. This magnesium loss appears to be secondary to increased urinary glucose, which increases urinary output.<sup>7</sup>

Therefore, inadequate magnesium intake seems to prompt a vicious cycle of low magnesium levels, elevated insulin and glucose levels, and excess magnesium excretion. In other words, the less magnesium your body has, the less it appears to be able to "hang onto it."<sup>8</sup>

*Rarely* do so many studies from around the world find universal agreement on a subject! The evidence is clear: if you want to optimize your metabolism and keep your risk for type 2 diabetes low, one of the things you need to do is consume adequate magnesium. Unfortunately, this is not the norm, as an estimated 80 percent of Americans are magnesium deficient.

## Are Your Magnesium Levels Up to Par?

Dietary surveys suggest that the majority of Americans are simply not getting enough magnesium from their diets alone. Other factors that can make you more prone to magnesium deficiency include:

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**An unhealthy digestive system:** which impairs your body's ability to absorb magnesium (Crohn's disease, [leaky gut](#), etc.)

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**Diabetes:** especially if poorly controlled, leading to increased magnesium loss in urine

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**Age:** older adults are more likely to be magnesium deficient because absorption decreases with age and the elderly are more likely to take medications that can interfere with absorption

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**Unhealthy kidneys:** which contribute to excessive loss of magnesium in the urine

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**Alcoholism:** up to 60 percent of alcoholics have low blood levels of magnesium

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**Certain medications:** diuretics, antibiotics, and medications used to treat cancer can result in magnesium deficiency

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## Magnesium Deficiency Can Lead to Heart Arrhythmias, Coronary Spasms, and Seizures

There's no lab test that will give you an accurate reading of the magnesium status in your tissues. The reason for this is that only one percent of the magnesium in your body is found in your blood. Fifty to 60 percent resides in your bones, and the remaining is in your soft tissues. Since most of your magnesium is stored *inside your cells and bone* rather than in blood plasma, there are no satisfactory blood tests for assessing it.

That said, some specialty labs do provide an RBC magnesium test, which is reasonably accurate. Other tests your doctor may use to evaluate your magnesium status include a 24-hour urine test or a sublingual epithelial test. Still, these can only give you an estimate of your levels, and doctors typically need to evaluate them in light of the symptoms you exhibit. Early signs of magnesium deficiency may include headaches, loss of appetite, nausea, and vomiting, and fatigue or weakness. However, ongoing magnesium deficiency can lead to far more serious symptoms such as:

- Abnormal heart rhythms and coronary spasms
- Muscle cramps and contractions
- Seizures
- Numbness and tingling

- Personality changes

In her book, *The Magnesium Miracle*, Dr. Carolyn Dean lists 100 factors that will help you decide whether or not you might be deficient. You can also follow the instructions in her blog post, "Gauging Magnesium Deficiency Symptoms,"<sup>9</sup> which will give you a checklist to go through every few weeks. This will help you gauge how much magnesium you need in order to take away your deficiency symptoms.

### Your Best Magnesium Source: REAL Food

Most people can keep their magnesium levels in the therapeutic range without resorting to supplements, simply by eating a varied diet, including plenty of [dark-green leafy vegetables](#). However, it is important to remember that the magnesium content of your foods depends on the richness of magnesium in the soil where they're grown. Most soils are now sorely depleted of nutrients, and for this reason, some magnesium experts, such as Dr. Dean, believe that virtually everyone needs to take supplemental magnesium. Organic foods may have more magnesium if grown in nutrient-rich soils but it is very difficult to make that determination.

One way to really increase your magnesium, as well as many other important plant-based nutrients, is by [juicing](#) your greens. I typically drink one pint to one quart of fresh green vegetable juice every day, and this is one of my primary sources of magnesium. An article in GreenMedInfo lists more than 20 foods that are exceptionally high in magnesium, including the following (for the full list, please refer to the original report). All listed portions equate to 100 grams, or just over three ounces:

Seaweed, agar, dried (770 mg)
Spices, <a href="#">basil</a> , dried (422 mg)
Spice, coriander leaf, dried (694 mg)
Flaxseed (392 mg)
Dried pumpkin seeds (535 mg)
Almond butter (303 mg)
Cocoa, dry powder, unsweetened (499 mg)
Whey, sweet, dried (176 mg)

### Magnesium Supplements, A to Z

The current government guidelines for magnesium intake among adults call for 300 to 420 mg per day (depending on your gender, age, pregnancy, and lactation), but many people consume less than 300 mg per day. The current research would suggest that many would benefit from a higher intake, about 700 mg per day or even more. Magnesium is lost in sweat during exercise and used up in higher amounts when a person is under stress.

If you opt for a supplement, be aware that there are a wide variety of magnesium supplements on the market, because magnesium must be bound to another substance. There's simply no such thing as a 100 percent magnesium supplement. The substance used in any given compound can affect the absorption and bioavailability of the magnesium, and may provide slightly different, or targeted, health benefits.

The table that follows summarizes some of the differences between the various forms. Magnesium threonate is likely one of the best sources, as it seems to penetrate cell membranes, including your mitochondria, which results in higher energy levels. Additionally, it also penetrates your blood-brain barrier and seems to do wonders to treat and prevent dementia and improve memory.

Besides taking a supplement, another way to improve your magnesium status is to take regular Epsom salt baths or foot baths. Epsom salt is a magnesium sulfate that can absorb into your body through your skin. Magnesium oil can also be used for topical application and absorption. Whatever supplement you choose, be sure to avoid any containing [magnesium stearate](#), a common but potentially hazardous additive.

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**Magnesium glycinate** is a chelated form of magnesium that tends to provide the highest levels of absorption and bioavailability and is typically considered ideal for those who are trying to correct a deficiency

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**Magnesium oxide** is a non-chelated type of magnesium, bound to an organic acid or a fatty acid. Contains 60 percent magnesium, and has stool softening properties

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**Magnesium chloride / Magnesium lactate** contain only 12 percent magnesium, but has better absorption than others, such as magnesium oxide, which contains five times more magnesium

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**Magnesium sulfate / Magnesium hydroxide** ([milk of magnesia](#)) are typically used as laxatives. Be aware that it's easy to overdose on these, so **ONLY** take as directed

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**Magnesium carbonate**, which has antacid properties, contains 45 percent magnesium

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**Magnesium taurate** contains a combination of magnesium and [taurine](#), an amino acid. Together, they tend to provide a calming effect on your body and mind

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**Magnesium citrate** is magnesium with citric acid, which has laxative properties

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**Magnesium threonate** is a newer, emerging type of magnesium supplement that appears promising, primarily due to its superior ability to penetrate the mitochondrial membrane, and may be the best magnesium supplement on the market

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## Balance Your Magnesium with Calcium, Vitamin K2, and D

One of the major benefits of getting your nutrients from a varied whole food diet is that you're less likely to end up with too much of one nutrient and not enough of another. Foods in general contain all the cofactors and needed co-nutrients in the proper ratios for optimal health... the wisdom of Nature takes out the guesswork. When you're using supplements, you need to become a bit savvier about how nutrients influence

and interact with each other.

For example, it's important to maintain the proper balance between magnesium, calcium, vitamin K2, and vitamin D. An appropriate magnesium to calcium ratio is currently thought to be 1:1, according to Dr. Dean who has studied this issue for the past 15 years. To learn more, please see my recent [interview](#) with her, in which she discusses the health benefits of this important mineral.

These four nutrients work together synergistically, and lack of balance between them is why calcium supplements have become associated with increased risk of heart attacks and stroke, and why some people experience vitamin D toxicity. To learn more about this, please see our [previous article](#) that delves into this topic in some depth. The above video focuses on the role of vitamin K, specifically.

## **Preventing Type 2 Diabetes Requires a Multi-Pronged Approach**

Type 2 diabetes, which involves loss of insulin and leptin sensitivity, is easily preventable, and nearly 100 percent reversible without drugs. However, preventing this terrible disease requires a multi-faceted approach. Getting adequate magnesium is just *one part* of the formula. The primary driving force behind obesity and type 2 diabetes is excessive dietary [fructose](#), which has adverse effects on all of your metabolic hormones, so it's important to address the sugar in your diet, particularly fructose. Other critical lifestyle factors include [exercise](#) and optimizing your [gut flora](#).

If you've been diagnosed with type 2 diabetes, it is best to avoid the pharmaceutical approach. Diabetes drugs fail to address the underlying problem, and many, like [Avandia](#), can have dangerous side effects. Avandia is linked to 43 percent increased risk of heart attack and 64 percent higher risk of cardiovascular death, compared with other treatments. For more tips on how to steer clear of the diabetes zone, refer to my comprehensive [diabetes article](#).