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Magnesium

There is a particular metal that can be lit on fire. Once lit and exposed to water, it actually burns hotter! This metal is magnesium and it must be eaten in order for us to survive. The atomic number of this mineral is 12 and its molecular weight is 24.305 g/mol. Every living organism needs magnesium for cellular function, so let's explore the wonders of this mineral.

Functions

ATP Production

The magnesium found in food acts as a means to attach the third phosphate to ATP (1,11). ATP is absolutely essential to cellular function and, thus, life. Despite how essential it is, it only makes up one ounce of weight for a 130 pound person. Half of that ounce of magnesium is stored in the bones, with the other half being in other soft tissue (11).

Ca⁺ Antagonist

Both calcium and magnesium are responsible for muscle contraction. Calcium causes muscle contractions while magnesium prevents them. These two minerals also regulate blood pressure (7, 11).

Magnesium given in an IV to a myocardial infarction patient helps to alleviate chest pain. Those who received magnesium improved their exercise duration 14% faster than those who did not consume magnesium intravenously (1,7). It would also make sense that the DASH diet is naturally high in magnesium rich foods as it's been shown to reduce blood pressure when consumed in adequate amounts (7). In fact, the average person with hypertension benefits from

magnesium supplementation by an average decrease of 12/8 mm Hg in blood pressure (3).

Research indicates that a deficiency could cause a constriction in blood vessels, which would further some theories that state that the increase in the prevalence of hypertension is due to an increase in magnesium deficiencies (11).

Blood Sugar and Insulin Control

Low levels of magnesium are common with people that have type-II diabetes, as low magnesium is often associated with poor blood sugar control (7). However, magnesium supplementation is believed to help lower A1C in those who have had chronically high blood glucose levels (11). A study done on black women done in the U.S. that increased magnesium consumption (mainly through whole grains) found that the risk of type-II diabetes decreased after magnesium intake increased (10).

By affecting insulin sensitivity, magnesium thus also affects immune system strength. The decrease in insulin sensitivity is related to a decrease in immune system health and function (11).

Recommended Intake

Recommended Dietary Allowances for magnesium for children and adults (10)				
Age (years)	Males (mg/day)	Females (mg/day)	Pregnancy (mg/day)	Lactation (mg/day)
1–3	80	80	N/A	N/A
4–8	130	130	N/A	N/A
9–13	240	240	N/A	N/A

Recommended Dietary Allowances for magnesium for children and adults (10)

Age (years)	Males (mg/day)	Females (mg/day)	Pregnancy (mg/day)	Lactation (mg/day)
14–18	410	360	400	360
19–30	400	310	350	310
31+	420	320	360	320

An RDA cannot ethically be established for infants. However, it's easy to see that magnesium RDA increases as one ages and it differs between sexes. Magnesium RDA increases after 31 as it helps retain bone density (9).

RDA can be a bit of a grey area, though. Magnesium is in “hard water”. The magnesium used in tap water is 50% bioavailable. The difference in intake is enough to see a decrease in the prevalence of heart disease in areas with hard water (11). This could mean that an intake above the RDA could actually be better at preventing CVD. The bioavailability of magnesium fluctuates significantly depending on the source and that can make establishing an RDA for it even more difficult, as it would require one to analyze the absorption of many different kinds of magnesium. Also, magnesium absorption fluctuates significantly with other minerals in that meal. Something as simple as having an enteric gelatin coating on a magnesium pill can reduce the absorption of magnesium by 50% (5). The Office of Dietary Supplements created a helpful chart shown below that shows how the source of magnesium affects the amount of pure magnesium found in the supplement, thus affecting how much is actually being consumed (7).

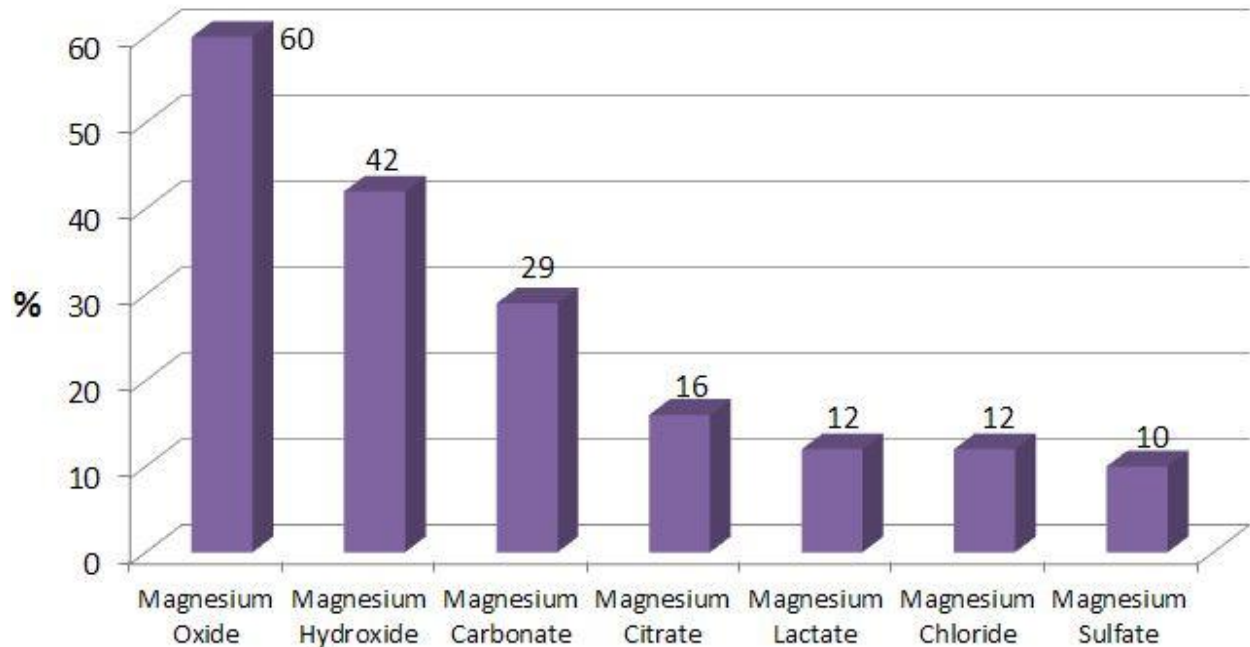


Figure 1: ■ Percent Magnesium content of oral supplements

Another thing to be mindful of is the fact that a UL has only been established for magnesium supplements. The UL for magnesium supplements is 350 mg per day (11). This means that it is very possible to go overboard on magnesium supplements, but one doesn't need to be concerned with consuming too much through food. However, magnesium supplements can also function as laxatives if one isn't careful with intake (7). It's interesting to note that one of the first things that can be noticed with too much magnesium is a change in mental status. Because of this fact, it's obvious to see that magnesium plays a huge role in cellular function in the brain and a deficiency or surplus could cause an imbalance in the brain (11).

Deficiency

There is no way to test for magnesium deficiency because only 1% of the body's magnesium is found in the blood (11). Also, there are no clear signs/symptoms that point directly to a

magnesium deficiency (1). With a mineral that's so vital to cell and organ function, there is very little known about how much magnesium we should be consuming for optimal health.

It's estimated that half of the U.S. population is deficient in magnesium (4,6,7). With the major symptoms of magnesium deficiency being a change in mental state, a decrease in appetite, chronic fatigue and weakness, and nausea, deficiencies should be taken seriously (4, 7). As mentioned earlier, if an imbalance between calcium and magnesium occurs then muscle contractions can be weak or sporadic (11).

Magnesium is crucial during growth and development due to its correlation with mental state. It has such a correlation with brain health that hallucinations can occur in cases of extreme deficiency (11). Due to its relation to bone density, along with adequate calcium consumption, magnesium consumption is also crucial to build bone mass. In the later years, magnesium and calcium intake are crucial for maintaining bone mass. Absorption decreases with age, however, making it especially important to have magnesium in the diet (5).

Due to its close relation to calcium, a severe magnesium deficiency can also cause a calcium deficiency and can even cause a potassium deficiency (11). Once a potassium, calcium, and magnesium deficiency is present, heart health quickly declines as blood pressure and cell function decreases. Bone health would also quickly decline as a deficiency in calcium and magnesium would cause the body to obtain both minerals from the bones (9).

Drug Interactions

Deficiencies in magnesium are more likely to be due to extraneous factors than through intake according to the latest literature. Alcohol abuse is a huge contributing factor to bodily magnesium status. 30-60% of alcoholics are believed to be deficient in magnesium (7). A

shocking 90% of those experiencing hallucinations from alcohol withdraw are also deficient in magnesium (7). Kidney disorders can cause a deficiency as it reduces the body's ability to retain dietary magnesium. Thus, any medications that act as diuretics severely interfere with the body's ability to regulate magnesium (11). Antibiotics also affect magnesium absorption and retention. If one were to have an organ transplant, issues could arise from long term antibiotics.

Physical Causes of Deficiency

Any sort of digestive issue could also play a huge role in magnesium requirements for an individual. For example, someone with Crohn's disease would need significantly more magnesium than someone without the disease (5). A gastric bypass surgery would be another common example of a situation where magnesium needs would increase and should be monitored on an individual basis.

Dietary Sources

Grains

As aforementioned, the source of magnesium is crucial for bioavailability purposes. The most concentrated sources of magnesium are whole grains and vegetables (7). Refined grains have the bran removed and that is the part of the plant that contains the most magnesium, so whole grains are the best route to go in terms of grains (11). According to the National Institutes of Health, wheat bran is actually the densest source of magnesium. Because it's from a natural source, it's also more bioavailable than most supplements as well (7).

Vegetables and Nuts

At the center of chlorophyll is magnesium, which means that the greenest vegetables usually offer the most magnesium. Spinach is the vegetable that contains the most magnesium, as made apparent by its dark green color (7). Almonds are the densest with magnesium out of all nuts. A form of magnesium supplement called magnesium acetate is actually derived from almonds and, thus, is the supplement with the highest bioavailability (5).

Supplementation

If one were to consume pure magnesium, diarrhea would occur. Hence why supplements are magnesium paired with another compound. Magnesium oxide has the highest concentration of magnesium out of all supplements. However, magnesium acetate is believed to be the most bioavailable (5, 7, 11). If a deficiency is present, magnesium oxide salts are recommended.

Conclusion

Magnesium is one of the most essential minerals. It's responsible for many bodily functions, including ATP production. Deficiencies occur in up to half of people in the U.S. And that explains why many people experience chronic fatigue. It's present in many foods including whole grains and green vegetables.

References

- Bender DA. Introduction to nutrition and metabolism. 4th ed. Boca Raton: CRC Press; 2008.
- Campbell MK, Farrell S. Biochemistry: 7th ed. Belmont: Cengage Learning; 2012.
- Dyckner T, Wester PO. Effect of magnesium on blood pressure. *B Med Journal*. 1983 Jun; 286: 1847-49.
- Elin RJ. Magnesium metabolism in health and disease. *Dis Mon*. 1988 Apr; 34(4): 161-218.
- Fine KD, Santa Ana CA, Porter JL, Fordtran JS. Intestinal absorption of magnesium from food and supplements. *J Clin Invest*. 1991 Aug; 88:396-402.
- Ford ES, Mokdad AH. Dietary magnesium intake in a national sample of U.S. adults. *J Nutr*. 2003 Sep; 133(9):2879-82.
- Magnesium [Internet]. Rockville: National Institutes of Health; Unknown [Cited 2009 July 13]. Available from: <http://ods.od.nih.gov/factsheets/Magnesium-HealthProfessional/>
- Mildvan AS. Role of magnesium and other divalent cations in ATP-utilizing enzymes. 1987; 6(1):28-33.
- Tucker KL, Hannan MT, Chen H, Cupples LA, Wilson PW, Kiel DP. Potassium, magnesium, and fruit and vegetable intakes are associated with greater bone mineral density in elderly men and women. *Am J Clin Nutr*. 1999 Apr; 69(4):727-36.
- Whitney E, Rolfes SR. Understanding nutrition. 11th ed. Boca Raton: CRC Press; 2010.
- Van Dam RM, Hu FB, Rosenberg L, Krishnan S, Palmer JR. Dietary calcium and magnesium, major food sources, and risk of type 2 diabetes in U.S. black women. *Diabetes Care*. 2006 Oct; 29(10):2238-43