Facts About Dietary Supplements

Clinical Nutrition Service, Warren Grant Magnuson Clinical Center • Office of Dietary Supplements • National Institutes of Health

Magnesium

As a consumer, you need information you can trust to help you make thoughtful decisions about eating a healthful diet and using vitamin and mineral supplements. Registered dietitians at the Warren Grant Magnuson Clinical Center, the clinical research hospital at the National Institutes of Health (NIH) in Bethesda, MD, developed this series of Fact Sheets in conjunction with the Office of Dietary Supplements in the Office of the Director of NIH to provide responsible information about the role of vitamins and minerals in health and disease and to help guide your decisions on the use of vitamin and mineral supplements. Each fact sheet in this series received extensive scientific review by recognized experts from the academic and research communities. The information is not intended to be a substitute for professional medical advice. It is important that you seek the advice of a physician about any medical condition or symptom. It is also important to seek the advice of a physician, registered dietitian, pharmacist, or other qualified health care professional about the appropriateness of taking dietary supplements and their potential interactions with medications.

Magnesium: What is it?

Magnesium is a mineral needed by every cell of your body. About half of your body's magnesium stores are found inside cells of body tissues and organs, and half are combined with calcium and phosphorus in bone. Only 1 percent of the magnesium in your body is found in blood. Your body works very hard to keep blood levels of magnesium constant (1).

Magnesium is needed for more than 300 biochemical reactions in the body. It helps maintain normal muscle and nerve function, keeps heart rhythm steady, and bones strong. It is also involved in energy metabolism and protein synthesis (2).

What foods provide magnesium?

Green vegetables such as spinach provide magnesium because the center of the chlorophyll molecule contains magnesium. Nuts, seeds, and some whole grains are also good sources of magnesium (3).

Although magnesium is present in many foods, it usually occurs in small amounts. As with most nutrients,daily needs for magnesium cannot be met from a single food. Eating a wide variety of foods, including five servings of fruits and vegetables daily and plenty of whole grains, helps to ensure an adequate intake of magnesium.

The magnesium content of refined foods is usually low (4). Whole-wheat bread, for example, has twice as much magnesium as white bread because the magnesium-rich germ and bran are removed when white flour is processed. The table of food sources of magnesium suggests many dietary sources of magnesium.

Water can provide magnesium, but the amount varies according to the water supply. "Hard" water contains more magnesium than "soft" water. Dietary surveys do not estimate magnesium intake from water, which may lead to underestimating total magnesium intake and its variability (4).

What is the Recommended Dietary Allowance for magnesium?
The Recommended Dietary Allowance (RDA) is the average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97-98 percent) individuals in each life-stage and gender group (4).

The 1999 RDAs for magnesium for adults (4), in milligrams (mg), are:

Life Stage	Men	Women	Pregnancy	Lactation
Ages 14 - 18	410 mg	360 mg	400 mg	360 mg
Ages 19 - 30	400 mg	310 mg	350 mg	310 mg
Ages 31 +	420 mg	320 mg	360 mg	320 mg

Results of two national surveys, the National Health and Nutrition Examination Survey (NHANES III-1988-91) (5) and the Continuing Survey of Food Intakes of Individuals (1994 CSFII) (4), indicated that the diets of most adult men and women do not provide the recommended amounts of magnesium. The surveys also suggested that adults age 70 and over eat less magnesium than younger adults, and that non-Hispanic black subjects consumed less magnesium than either non-Hispanic white or Hispanic subjects (4).

When can magnesium deficiency occur?
Even though dietary surveys suggest that many Americans do not consume magnesium in recommended amounts, magnesium deficiency is rarely seen in the United States in adults. When magnesium deficiency does occur, it is usually due to excessive loss of magnesium in urine, gastrointestinal system disorders that cause a loss of magnesium or limit magnesium absorption, or a chronically low intake of magnesium (4, 6-9).

Treatment with diuretics (water pills), some antibiotics, and some medicine used to treat cancer, such asCisplatin, can increase the loss of magnesium in urine (4, 10). Poorly controlled diabetes increases loss of magnesium in urine, causing a depletion of magnesium stores (6). Alcohol also increases excretion of magnesium in urine, and a high alcohol intake has been associated with magnesium deficiency (11, 12).

Gastrointestinal problems, such as malabsorption disorders, can cause magnesium depletion by preventing the body from using the magnesium in food. Chronic or excessive vomiting and diarrhea may also result in magnesium depletion (1, 9).

Signs of magnesium deficiency include confusion, disorientation, loss of appetite, depression, muscle contractions and cramps, tingling, numbness, abnormal heart rhythms, coronary spasm, and seizures (1, 4, 9).

Who may need extra magnesium?

Healthy adults who eat a varied diet do not generally need to take a magnesium supplement. Magnesium supplementation is usually indicated when a specific health problem or condition causes an excessive loss of magnesium or limits magnesium absorption (2, 6, 7, 11-16).

Extra magnesium may be required by individuals with conditions that cause excessive urinary loss of magnesium, chronic malabsorption, severe diarrhea and steatorrhea, and chronic or severe vomiting.

Loop and thiazide diuretics, such as Lasix, Bumex, Edecrin, and Hydrochlorothiazide, can increase loss of magnesium in urine (7). Medicines such as Cisplatin (10), which is widely used to treat cancer, and the antibiotics Gentamicin, Amphotericin, and Cyclosporin also cause the kidneys to excrete (lose) more magnesium in urine (6). Doctors routinely monitor magnesium levels of individuals who take these medicines and prescribe magnesium supplements if indicated.

Poorly controlled diabetes increases loss of magnesium in urine and may increase an individual's need for magnesium. A medical doctor would determine the need for extra magnesium in this situation. Routine supplementation with magnesium is not indicated for individuals with well-controlled diabetes (14, 15, 17, 18).

People who abuse alcohol are at high risk for magnesium deficiency because alcohol increases urinary excretion of magnesium. Low blood levels of magnesium occur in 30 percent to 60 percent of alcoholics, and in nearly 90 percent of patients experiencing alcohol withdrawal (12). In addition, alcoholics who substitute alcohol for food will usually have lower magnesium intakes (11, 12). Medical doctors routinely evaluate the need for extra magnesium in this population.

The loss of magnesium through diarrhea and fat malabsorption usually occurs after intestinal surgery or infection, but it can occur with chronic malabsorptive problems such as Crohn's disease, gluten sensitive enteropathy, and regional enteritis (13). Individuals with these conditions may need extra magnesium. The most common symptom of fat malabsorption, or steatorrhea, is passing greasy, offensive-smelling stools.

Occasional vomiting should not cause an excessive loss of magnesium, but conditions that cause frequent or severe vomiting may result in a loss of magnesium large enough to require supplementation. In these situations, your medical doctor would determine the need for a magnesium supplement.

Individuals with chronically low blood levels of potassium and calcium may have an underlying problem with magnesium deficiency. Adding magnesium supplements to their diets may make potassium and calcium supplementation more effective for them (2, 16). Doctors routinely evaluate magnesium status when potassium and calcium levels are abnormal, and prescribe a magnesium supplement when indicated.

What is the best way to get extra magnesium?

Doctors will measure blood levels of magnesium whenever a magnesium deficiency is suspected. When levels are mildly depleted, increasing dietary intake of magnesium can help restore blood levels to normal. Eating at least five servings of fruits and vegetables daily, and choosing dark-green leafy vegetables often, as recommended by the Dietary Guidelines for Americans, the Food Guide Pyramid, and the Five-a-Day program, will help adults at-risk of having a magnesium deficiency consume recommended amounts of magnesium. When blood levels of magnesium are very low, an intravenous drip (IV drip) may be needed to return levels to normal. Magnesium tablets also may be prescribed, but some forms, in particular magnesium salts, can cause diarrhea (19). Your medical doctor or qualified health-care provider can recommend the best way to get extra magnesium when it is needed.

What are some current issues and controversies about magnesium?

Magnesium and blood pressure

Evidence suggests that magnesium may play an important role in regulating blood pressure (4). Diets that provide plenty of fruits and vegetables, which are good sources of potassium and magnesium, are consistently associated with lower blood pressure (20-22). The DASH study (Dietary Approaches to Stop Hypertension) suggested that high blood pressure could be significantly lowered by a diet high in magnesium, potassium, and calcium, and low in sodium and fat (23-26). In another study, the effect of various nutritional factors on incidence of high blood pressure was examined in over 30,000 U.S. male health professionals. After four years of follow-up, it was found that a greater magnesium intake was significantly associated with a lower risk of hypertension (27). The evidence is strong enough that the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure recommends maintaining an adequate magnesium intake as a positive lifestyle modification for preventing and managing high blood pressure (28-30).

Magnesium and heart disease
Magnesium deficiency can cause metabolic changes that may contribute to heart attacks and strokes (31-33). There is also evidence that low body stores of magnesium increase the risk of abnormal heart rhythms (4), which may increase the risk of complications associated with a heart attack. Population surveys have associated higher blood levels of magnesium with lower risk of coronary heart disease (34-36). In addition, dietary surveys have suggested that a higher magnesium intake is associated with a lower risk of stroke (37). Further studies are needed to understand the complex relationships between dietary magnesium intake, indicators of magnesium status, and heart disease.

Magnesium and osteoporosis
Magnesium deficiency may be a risk factor for postmenopausal osteoporosis (4). This may be due to the fact that magnesium deficiency alters calcium metabolism and the hormone that regulates calcium (13). Several studies have suggested that magnesium supplementation may improve bone mineral density (4), but researchers believe that further investigation on the role of magnesium in bone metabolism and osteoporosis is needed.

Magnesium and diabetes
Magnesium is important to carbohydrate metabolism. It may influence the release and activity of insulin, the hormone that helps control blood glucose levels (15). Elevated blood glucose levels increase the loss of magnesium in the urine, which in turn lowers blood levels of magnesium [(14). This explains why low blood levels of magnesium (hypomagnesemia) are seen in poorly controlled type 1 and type 2 diabetes.

In 1992, the American Diabetes Association issued a consensus statement that concluded: "Adequate dietary magnesium intake can generally be achieved by a nutritionally balanced meal plan as recommended by the American Diabetes Association." It recommended that "... only diabetic patients at high risk of hypomagnesemia should have total serum (blood) magnesium assessed, and such levels should be repleted (replaced) only if hypomagnesemia can be demonstrated" (18).

What is the health risk of too much magnesium?
Dietary magnesium does not pose a health risk, however very high doses of magnesium supplements, which may be added to laxatives, can promote adverse effects such as diarrhea. Magnesium toxicity is more often associated with kidney failure, when the kidney loses the ability to remove excess magnesium. Very large doses of laxatives also have been associated with magnesium toxicity, even with normal kidney function (38). The elderly are at risk of magnesium toxicity because kidney function declines with age and they are more likely to take magnesium-containing laxatives and antacids.

Signs of excess magnesium can be similar to magnesium deficiency and include mental status changes, nausea, diarrhea, appetite loss, muscle weakness, difficulty breathing, extremely low blood pressure, and irregular heartbeat (4, 39-41).

The Institute of Medicine of the National Academy of Sciences has established a tolerable upper intake level (UL) for supplementary magnesium for adolescents and adults at 350 mg daily. As intake increases above the UL, the risk of adverse effects increases (4).

Table of Food Sources of Magnesium (3)

Food	*Milligrams*	*% DV**
100 percent Bran, 2 Tbs	44	11
Avocado, Florida, 1/2 med	103	26
Wheat germ, toasted, 1 oz	90	22
Almonds, dry roasted, 1 oz	86	21
Cereal, shredded wheat, 2 rectangular biscuits	80	20
Seeds, pumpkin, 1/2 oz	75	19
Cashews, dry roasted, 1 oz	73	18
Nuts, mixed, dry roasted, 1 oz	66	17
Spinach, cooked, 1/2 c	65	16
Bran flakes, 1/2 c	60	15
Cereal, oats, instant/fortified, cooked w/ water, 1 c	56	14
Potato, baked w/ skin, 1 med	55	14
Soybeans, cooked, 1/2 c	54	14
Peanuts, dry roasted, 1 oz	50	13
Peanut butter, 2 Tbs.	50	13

Table of Food Sources of Magnesium (3)

Food	*Milligrams*	*% DV**
Chocolate bar, 1.45 oz	45	11
Vegetarian baked beans, 1/2 c	40	10
Potato, baked w/out skin, 1 med	40	10
Avocado, California, 1/2 med	35	9
Lentils, cooked, 1/2 c	35	9
Banana, raw, 1 medium	34	9
Shrimp, mixed species, raw, 3 oz (12 large)	29	7
Tahini, 2 Tbs	28	7
Raisins, golden seedless, 1/2 c packed	28	7
Cocoa powder, unsweetened, 1 Tbs	27	7
Bread, whole wheat, 1 slice	24	6
Spinach, raw, 1 c	24	6
Kiwi fruit, raw, 1 med	23	6
Hummus, 2 Tbs	20	5
Broccoli, chopped, boiled, 1/2 c	19	5

*DV = Daily Value. DVs are reference numbers based on the Recommended Dietary Allowance (RDA). They were developed to help consumers determine if a food contains very much of a specific nutrient. The DV for magnesium is 400 milligrams (mg). The percent DV (%DV) listed on the nutrition facts panel of food labels tells adults what percentage of the DV is provided by one serving. Even foods that provide lower percentages of the DV will contribute to a healthful diet.

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References

1. Rude RK. Magnesium deficiency: A cause of heterogeneous disease in humans. J Bone Miner Res 1998;13:749-58.
2. Wester PO. Magnesium. Am J Clin Nutr 1987;45:1305-12.
3. U.S. Department of Agriculture Agricultural Research Service. Nutrient Database for Standard Reference.
4. Institute of Medicine. Food and Nutrition Board. Dietary Reference Intakes: Calcium, Phosphorus, Magnesium, Vitamin D and Fluoride. National Academy Press. Washington, DC, 1999.
5. Alaimo K, McDowell, M.A., Briefel, R.R, Bischlf, A.M, Caughman, C.R, Loria, C.M, Johnson, C.L. Dietary Intake of Vitamins, Minerals, and Fiber of Persons Ages 2 Months and Over in the United States: Third National Health and Nutrition Examination Survey, Phase 1, 1988-91. In: Johnson GV, ed. Vital and Health Statistics of the Center for Disease Control and Prevention / National Center for Health Statistics, Hyattsville, MD 1994:1-28.
6. Kelepouris E and Agus ZS. Hypomagnesemia: Renal magnesium handling. Semin Nephrol 1998;18:58-73.
7. Ramsay LE, Yeo WW, Jackson PR. Metabolic effects of diuretics. Cardiology 1994;84 Suppl 2:48-56.
8. Ladefoged K, Hessov I, Jarnum S. Nutrition in short-bowel syndrome. Scand J Gastroenterol Suppl 1996;216:122-31.
9. Kobrin SM and Goldfarb S. Magnesium Deficiency. Semin Nephrol 1990;10:525-535.
10. Lajer H and Daugaard G. Cisplatin and hypomagnesemia. Ca Treat Rev 1999;25:47-58.
11. Elisaf M, Bairaktari E, Kalaitzidis R, Siamopoulos K. Hypomagnesemia in alcoholic patients. Alcohol Clin Exp Res 1998;22:244-246.

12. Abbott L, Nadler J, Rude RK. Magnesium deficiency in alcoholism: Possible contribution to osteoporosis and cardiovascular disease in alcoholics. Alcohol Clin Exp Res 1994;18:1076-82.

13. Rude RK and Olerich M. Magnesium deficiency: Possible role in osteoporosis associated with gluten-sensitive enteropathy. Osteoporos Int 1996;6:453-61.

14. Tosiello L. Hypomagnesemia and diabetes mellitus. A review of clinical implications. Arch Intern Med 1996;156:1143-8.

15. Paolisso G, Scheen A, D'Onofrio F, Lefebvre P. Magnesium and glucose homeostasis. Diabetologia 1990;33:511-4.

16. Elisaf M, Milionis H, Siamopoulos K. Hypomagnesemic hypokalemia and hypocalcemia: Clinical and laboratory characteristics. Mineral Electrolyte Metab 1997;23:105-112.

17. Paolisso G, Sgambato S, Gambardella A, Pizza G, Tesauro P, Varricchio H, D'Onofrio F. Daily magnesium supplements improve glucose handling in elderly subjects. Am J Clin Nutr 1992;55:1161-7.

18. American Diabetes Association. Magnesium supplementation in the treatment of diabetes. Diabetes Care 1992:1065-1067.

19. DePalma J. Magnesium Replacement Therapy. Am Fam Phys 1990;42:173-76.

20. Appel LJ. Nonpharmacologic therapies thatreduce blood presure: A fresh perspective. Clin Cardiol 1999;22:1111-5.

21. Simopoulos AP. The nutritional aspects of hypertension. Compr Ther 1999;25:95-100.

22 . Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM, Bray GA, Vogt TM, Cutler JA, Windhauser MM, Lin PH, Karanja N. A clinical trial of the effects of dietary patterns on blood pressure. N Engl J Med 1997;336:1117-24.

23. Sacks FM, Obarzanek E, Windhauser MM, Svetkey LP, Vommer WM, McCullough M, Karanja N, Lin PH, Steele P, Praschen MA, Evans M, Appel LJ, Bray GA, Vogt T, Moore MD for the DASH investigators. Rationale and design of the Dietary Approaches to Stop Hypertension trial (DASH). A multicenter controlled-feeding study of dietary patterns to lower blood pressure. Ann Epidemiol 1995;5:108-18.

24. Sacks FM, Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Bray GA, Vogt TM, Cutler JA, Windhauser MM, Lin PH, Karanja N. A dietary approach to prevent hypertension: A review of the Dietary Approaches to Stop Hypertension (DASH) Study. Clin Cardiol 1999;22:6-10.

25. Svetkey LP, Simons-Morton D, Vollmer WM, Appel LJ, Conlin PR, Ryan DH, Ard J, Kennedy BM. Effects of dietary patterns on blood pressure: Subgroup analysis of the Dietary Approaches to Stop Hypertension (DASH) randomized clinical trial. Arch Intern Med 1999;159:285-93.

26. Reusser ME and McCarron DA. Micronutrient effects on blood pressure regulation. Nutr Rev 1994;52:367-75.

27. Ascherio A, Rimm EB, Giovannucci EL, Colditz GA, Rosner B, Willett WC, Sacks FM, Stampfer MJ. A prospective study of nutritional factors and hypertension among US men. Circulation 1992;86:1475-84.

28. National Heart, Lung, and Blood Institute. Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. The sixth report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Arch Intern Med 1997;157:2413-46.

29. Schwartz GL and Sheps SG. A review of the sixth report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Curr Opin Cardiol 1999;14:161-8.

30. Kaplan NM. Treatment of hypertension: Insights from the JNC-VI report. Am Fam Physician 1998;58:1323-30

31. Altura BM and Altura BT. Magnesium and cardiovascular biology: An important link between cardiovascular risk factors and atherogenesis. Cell Mol Biol Res 1995;41:347-59.

32. Caspi J, Rudis E, Bar I, Safadi T, Saute M. Effects of magnesium on myocardial function after coronary artery bypass grafting. Ann Thorac Surg 1995;59:942-7.

33. Ravn HB, Vissinger H, Kristensen SD, Wennmalm A, Thygesen K, Husted SE. Magnesium inhibits platelet activity--an infusion study in healthy volunteers. Thromb Haemot 1996;75:939-44.

34. Ford ES. Serum magnesium and ischaemic heart disease: Findings from a national sample of US adults. Intl J of Epidem 1999;28:645-651. 35. Liao F, Folsom A, Brancati F. Is low magnesium concentration a risk factor for coronary heart disease? The Atherosclerosis Risk in Communities (ARIC) Study. Am Heart J 1998;136:480-90.

36. Gartside P and Glueck C. The important role of modifiable dietary and behavioral characteristics in the causation and prevention of coronary heart disease hospitalization and mortality: The prospective NHANES I follow-up study. J Am Coll Nutr 1995;14:71-79.

37. Ascherio A, Rimm EB, Hernan MA, Giovannucci EL, Kawachi I, Stampfer MJ, Willett WC. Intake of potassium, magnesium, calcium, and fiber and risk of stroke among US men. Circulation 1998;98:1198-204.

38. Qureshi T and Melonakos TK. Acute hypermagnesemia after laxative use. Ann Emerg Med 1996;28:552-5.

39. Whang R. Clinical disorders of magnesium metabolism. Compr Ther 1997;23:168-73.

40. Ho J, Moyer TP, Phillips S. Chronic diarrhea: The role of magnesium. Mayo Clin Proc1995;70:1091-1092.

41. Nordt S, Williams SR, Turchen S, Manoguerra A, Smith D, Clark R. Hypermagnesemia following an acute ingestion of Epsom salt in a patient with normal renal function. J Toxicol Clin Toxicol 1996;34:735-9.

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