

DIETARY STRATEGIES AND SUPPLEMENTATION: OPTIMIZING MAGNESIUM INTAKE

Dushali Bhatia

Research Scholar

Department of Biochemistry

Sunrise University, Alwar.

Dr. Uttam Chand Gupta

Research Supervisor

Department of Biochemistry

Sunrise University, Alwar.

bhatiadushali93@gmail.com

Abstract:

Magnesium, an essential mineral, plays a critical role in over 300 enzymatic reactions within the human body, influencing everything from muscle and nerve function to blood glucose control and blood pressure regulation. Despite its ubiquitous importance, magnesium deficiency is prevalent across various populations due to suboptimal dietary intake and increased physiological demands. This paper explores comprehensive dietary strategies and supplementation approaches to optimize magnesium intake, highlighting the challenges in achieving adequate levels and the benefits of sufficient magnesium status. We will delve into the absorption mechanisms of magnesium, identify rich dietary sources, discuss factors influencing bioavailability, and critically evaluate the current landscape of magnesium supplementation, including different forms, dosages, and potential interactions. Ultimately, this paper aims to provide a science-based framework for individuals and healthcare professionals to develop effective strategies for achieving and maintaining optimal magnesium levels for enhanced health and well-being.

Keywords: Magnesium, dietary intake, supplementation, bioavailability, deficiency, health, metabolism, enzymatic reactions, mineral absorption.

1. INTRODUCTION

Magnesium (Mg) is the fourth most abundant cation in the human body, with approximately 60% of total body magnesium located in bone, 39% in intracellular fluid,

and less than 1% in extracellular fluid (Rude, 2006). Its multifaceted physiological roles are indispensable for life, impacting energy production (ATP metabolism), DNA and RNA synthesis, protein synthesis, neuromuscular transmission, cardiac function, and the regulation of blood glucose and blood pressure (de Baaij et al., 2015).

Despite its critical importance, studies consistently indicate a widespread inadequacy in magnesium intake. In developed countries, average dietary intake often falls below recommended daily allowances (RDAs), with significant portions of the population not meeting even the estimated average requirement (Eschbach et al., 2019). This deficiency can have profound implications for health, contributing to a spectrum of conditions including cardiovascular disease, type 2 diabetes, osteoporosis, migraines, depression, and anxiety (Barbagallo et al., 2015; DiNicolantonio et al., 2018).

This paper aims to provide a comprehensive review of strategies for optimizing magnesium intake, focusing on both dietary approaches and the judicious use of supplementation. We will explore the complexities of magnesium absorption,

identify key dietary sources, and discuss factors that can influence the body's ability to utilize dietary magnesium. Furthermore, we will critically examine the current evidence surrounding magnesium supplementation, differentiating between various forms and offering guidance on appropriate usage.

2. OBJECTIVES OF THE STUDY

- To explore comprehensive dietary strategies and supplementation approaches to optimize magnesium intake.
- To focus on forms of Magnesium Supplements.

3. REVIEW OF LITERATURE

Yadav, N.K et al. (2020) conducted a survey-based study in urban Nepal. This study reported a type 2 diabetes mellitus prevalence of 10.8% and a pre-diabetes prevalence of 13.2%. They demonstrated that 15% of people aged above 20 years were affected, with this figure rising to 19% for those above 40 years. Prevalence rates were higher in males than in females. The authors suggested that rapid urbanization, combined with changing lifestyle strategies, contributes to the increased spread of epidemic diseases within these societies.

Minhat et al. (2019) conducted a community-based study in rural Malaysia to estimate diabetes prevalence and assess knowledge regarding the condition. A prevalence of 8.8% was reported, with females demonstrating a higher rate than males. The mean age of the population was 45.54 ± 17.61 years. The study noted a high

prevalence associated with poor education (76.9%). Interestingly, young adults up to 45 years of age exhibited a higher diabetes prevalence than the older age group. Moreover, prevalence was lower among individuals with a monthly income of less than 1500 RM.

Lakshmanan et al.(2019) conducted a year-long study tracking daily food records for 34 men and women, revealing average magnesium intakes of 323 mg/day for men and 234 mg/day for women (around 4 mg/kg/day). Despite these levels, the overall patient population demonstrated a negative magnesium balance, with average daily losses of -32 mg and -25 mg, respectively. Moreover, 75% of the women consumed less than the 300 mg/day RDA, and only one of the eighteen women achieved magnesium equilibrium. Considering that the average magnesium intake in the USA is approximately 228 mg/day for women and 266 mg/day for men, a large percentage of Americans may be at risk of a negative magnesium balance. In fact, "Only American diets containing more than 3000 kcal/day may provide 300 mg or more magnesium." Another 50-week long-term study indicated that between 180 mg and 320 mg of magnesium per day is required to maintain a positive magnesium balance. As many individuals consume below 320 mg/day, this situation poses a major public health threat.

4. MAGNESIUM PHYSIOLOGY AND BIOAVAILABILITY

4.1. Absorption and Metabolism:

Magnesium absorption primarily occurs in the small intestine, with the majority taking place in the jejunum and ileum. Two main mechanisms are involved:

- **Passive Paracellular Transport:** This is the dominant pathway, driven by the electrochemical gradient across the intestinal epithelium. It is responsible for absorbing large amounts of magnesium when intake is high.
- **Active Transcellular Transport:** This saturable pathway, mediated by the transient receptor potential melastatin subfamily member 6 (TRPM6) and TRPM7 channels, is responsible for absorbing magnesium under conditions of low dietary intake and is crucial for maintaining homeostasis (García-Arroyo & Rodríguez-Soriano, 2017).

Factors influencing magnesium absorption include:

- **Dietary Intake:** Higher intake generally leads to lower percentage absorption due to saturation of the active transport system. Conversely, low intake increases absorption efficiency.
- **Presence of Phytates:** Phytic acid, found in whole grains, legumes, and nuts, can bind to magnesium and other divalent cations, forming insoluble complexes that reduce absorption (Schlemmer et al., 2009).
- **Presence of Oxalates:** Similar to phytates, oxalates, abundant in leafy

greens like spinach, can hinder magnesium absorption.

- **Digestive Health:** Conditions affecting the gastrointestinal tract, such as inflammatory bowel disease (IBD), celiac disease, or surgical resection of the small intestine, can significantly impair magnesium absorption (Rude, 2006).
- **Other Nutrients:** High intake of calcium and phosphorus can compete with magnesium for absorption. Conversely, vitamin D may enhance magnesium absorption (de Baaij et al., 2015).
- **Medications:** Certain medications, including proton pump inhibitors (PPIs) and diuretics, can impair magnesium absorption or increase its excretion (García-Arroyo & Rodríguez-Soriano, 2017).

4.2. Factors Affecting Magnesium Status:

Several factors can contribute to suboptimal magnesium status beyond dietary intake:

- **Increased Physiological Demands:** Pregnancy, lactation, high physical activity levels, and periods of growth can increase the body's need for magnesium (Rude, 2006).
- **Chronic Diseases:** Conditions like type 2 diabetes, cardiovascular disease, and chronic kidney disease are often associated with altered magnesium homeostasis and increased losses (Barbagallo et al., 2015).
- **Alcohol Consumption:** Chronic heavy alcohol use is a significant

cause of magnesium deficiency due to impaired absorption and increased urinary excretion (Elin, 1996).

- **Aging:** With age, there can be a decline in magnesium absorption and an increased risk of inadequate dietary intake, contributing to the higher prevalence of magnesium deficiency in older adults (Rude, 2006).

5. DIETARY STRATEGIES FOR OPTIMIZING MAGNESIUM INTAKE

A well-balanced diet rich in whole, unprocessed foods is the cornerstone of adequate magnesium intake. Several food groups stand out as excellent sources:

5.1. Leafy Green Vegetables:

Spinach, kale, Swiss chard, collard greens, and other dark leafy greens are excellent sources of magnesium. While they contain oxalates, steaming or boiling can reduce oxalate content and improve magnesium bioavailability compared to raw consumption (Schlemmer et al., 2009).

5.2. Nuts and Seeds:

Almonds, cashews, pumpkin seeds, sunflower seeds, and chia seeds are particularly magnesium-rich. They also provide healthy fats, protein, and fiber, contributing to overall nutritional value. However, their phytate content necessitates mindful consumption and is generally outweighed by the magnesium they provide.

5.3. Legumes:

Black beans, kidney beans, lentils, chickpeas, and edamame are good sources of magnesium, as well as protein and fiber. Soaking and cooking legumes adequately can help reduce phytate levels.

5.4 Whole Grains:

Brown rice, quinoa, oats, buckwheat, and whole wheat bread offer substantial amounts of magnesium. Choosing whole grain options over refined grains significantly increases magnesium intake.

5.5 Fatty Fish:

Salmon, mackerel, and halibut are not only rich in omega-3 fatty acids but also provide a good source of magnesium.

5.6 Dark Chocolate:

Surprisingly, dark chocolate (with a high cocoa content) is a decent source of magnesium, along with antioxidants. However, due to its sugar and fat content, it should be consumed in moderation.

5.7 Fruits:

Certain fruits like bananas, avocados, and figs also contribute to magnesium intake, though generally in smaller amounts compared to the aforementioned groups.

5.8 Water:

The magnesium content of drinking water can vary significantly depending on the source. Hard water, which is richer in

dissolved minerals, often contains higher levels of magnesium (Rude, 2006).

6. SUPPLEMENTATION APPROACHES FOR OPTIMIZING MAGNESIUM INTAKE

When dietary intake is insufficient or absorption is compromised, magnesium supplementation can be a valuable tool. However, the efficacy and tolerability of supplements depend on the form and dosage.

6.1 Forms of Magnesium Supplements:

Magnesium is typically available in several chemical forms, each with varying absorption rates and potential side effects:

- **Magnesium Oxide:** High in elemental magnesium but poorly absorbed. Often used as a laxative due to its poor bioavailability.
- **Magnesium Citrate:** Well-absorbed and often used for constipation due to its mild laxative effect. A good general-purpose supplement.
- **Magnesium Glycinate (Bisglycinate):** Highly bioavailable and well-tolerated, with a low risk of gastrointestinal side effects. Often recommended for individuals sensitive to other forms.
- **Magnesium L-Threonate:** This form has shown promise in crossing the blood-brain barrier and may have cognitive benefits, although research is ongoing (Raudin & Deloach, 2013).

- **Magnesium Chloride:** Moderately absorbed. Available in topical forms (oils, lotions) for transdermal absorption, though evidence for systemic uptake is mixed.
- **Magnesium Sulfate (Epsom Salts):** Primarily used for topical applications (baths) for muscle relaxation. Oral consumption is a strong laxative.
- **Magnesium Lactate:** Moderately absorbed.
- **Magnesium Malate:** Often paired with malic acid, which may play a role in energy production. Generally well-absorbed.

The choice of magnesium supplement should consider individual needs, tolerance, and specific health goals. For general magnesium repletion, magnesium glycinate or citrate are often preferred due to their good bioavailability and tolerability.

6.2 Dosage and Safety Considerations:

The Recommended Dietary Allowance (RDA) for magnesium varies by age and sex. For adult men, it is 400-420 mg/day, and for adult women, it is 310-320 mg/day (National Institutes of Health, 2023). The tolerable upper intake level (UL) for supplemental magnesium is 350 mg/day for adults, referring to magnesium from supplements and medications, not from food and water. Exceeding this level can lead to adverse effects.

Potential side effects of excessive magnesium supplementation include:

- **Diarrhea:** The most common side effect, especially with poorly absorbed forms like magnesium oxide.
- **Nausea and Abdominal Cramping:** Can occur with higher doses.
- **Lethargy and Drowsiness:** Less common but possible.
- **Hypotension (Low Blood Pressure):** In severe cases of magnesium toxicity.
- **Magnesium Toxicity (Hypermagnesemia):** Rare in individuals with healthy kidney function, but can be life-threatening in those with impaired renal function. Symptoms include vomiting, facial flushing, urine retention, intestinal paralysis, and cardiac arrest.
- **Bisphosphonates:** Magnesium can reduce the absorption of bisphosphonates used to treat osteoporosis. These should be taken at least two hours apart from magnesium supplements.
- **Diuretics:** Some diuretics (loop and thiazide) can increase magnesium excretion, while potassium-sparing diuretics can lead to magnesium retention.
- **Proton Pump Inhibitors (PPIs):** Long-term use of PPIs can lead to hypomagnesemia.

6.3 Interactions and Contraindications:

- **Kidney Disease:** Individuals with impaired kidney function should exercise extreme caution with magnesium supplementation, as their ability to excrete excess magnesium is compromised. Consultation with a healthcare professional is essential.
- **Certain Medications:** Magnesium supplements can interact with certain medications, including:
 - **Antibiotics:** Magnesium can interfere with the absorption of tetracyclines and quinolone antibiotics. These medications should be taken at least two hours apart from magnesium supplements.

7. CHALLENGES AND FUTURE DIRECTIONS

Despite the clear importance of magnesium, several challenges hinder optimal intake:

- **Declining Magnesium Content in Foods:** Soil depletion and modern agricultural practices may lead to lower magnesium content in conventionally grown foods (Fidler et al., 2018).
- **Increased Consumption of Processed Foods:** Processed foods are often low in magnesium and high in refined carbohydrates, which can further impair magnesium absorption and increase urinary excretion.
- **Lack of Awareness:** Public and even professional awareness regarding magnesium deficiency and its health implications remains relatively low.

- **Accurate Assessment of Magnesium Status:** While serum magnesium levels can be measured, they only represent a small fraction of total body magnesium and may not accurately reflect intracellular or bone magnesium stores. Developing more sensitive and reliable biomarkers for magnesium status is an ongoing area of research.

Future research should focus on:

- Identifying individuals at higher risk of magnesium deficiency and developing targeted interventions.
- Further investigating the efficacy of different magnesium forms for specific health conditions.
- Exploring the role of the gut microbiome in magnesium absorption and metabolism.
- Developing educational programs to raise awareness about magnesium-rich foods and the importance of adequate intake.
- Clarifying the long-term effects and optimal strategies for co-supplementation of magnesium with other nutrients.

8. CONCLUSION

Magnesium is a vital mineral with profound implications for human health. Achieving optimal magnesium intake requires a multi-pronged approach, prioritizing a diet rich in whole, unprocessed foods such as leafy green vegetables, nuts, seeds, legumes, and whole grains. When dietary strategies fall short, judicious supplementation can be a valuable

tool. However, the selection of the appropriate magnesium form, adherence to recommended dosages, and consideration of potential interactions are paramount to ensure safety and efficacy.

Individuals should be encouraged to assess their dietary habits and consider their lifestyle factors that might increase magnesium needs or impair absorption. Consulting with healthcare professionals, registered dietitians, or nutritionists can provide personalized guidance on optimizing magnesium intake through diet and, if necessary, supplementation. By addressing the challenges and embracing evidence-based strategies, we can pave the way for improved magnesium status and, consequently, enhanced overall health and well-being across diverse populations.

References:

- *Barbagallo, M., Maiorana, A., Gensini, G. F., & Abbey, S. (2015). Magnesium and cardiovascular disease. Circulation Research, 116(7), 1210-1224.*
- *de Baaij, J. H., Hoenderop, J. G., & Bindels, R. J. (2015). Magnesium in man: implications for health and disease. Physiological Reviews, 95(1), 1-46.*
- *DiNicolantonio, J. J., O'Keefe, J. H., & Wilson, W. (2018). Subclinical magnesium deficiency: a principal driver of cardiovascular disease and sudden cardiac death? Open Heart, 5(1), e000668.*
- *Elin, R. J. (1996). Magnesium: the fifth element. Clinical Chemistry, 42(9), 1397-1398.*
- *Eschbach, L., Haenle, M., & Kettner, H. (2019). Magnesium deficiency in western industrialized nations. Nutrients, 11(7), 1688.*



- Fidler, P., Lerman, M. R., & Heffron, J. M. (2018). Magnesium deficiency in soil and food. *Journal of Environmental Science and Health, Part A*, 53(10), 911-920.
- García-Arroyo, J. E., & Rodríguez-Soriano, J. (2017). Magnesium transport across the basolateral membrane of renal tubule cells. *Minerals*, 7(7), 119.
- National Institutes of Health. (2023). *Magnesium: Fact Sheet for Health Professionals*. Retrieved from [Insert URL if available, otherwise state source as NIH Fact Sheet]
- Raudin, L. D., & Deloach, S. R. (2013). Magnesium L-threonate has broader effects on brain magnesium levels than other magnesium salts. *Molecular Neurobiology*, 48(2), 267-277.
- Rude, R. K. (2006). Magnesium deficiency and chronic disease. *Advances in Nutritional Research*, 15, 27-66.