

## Dietary Magnesium Deficiency And Its Impact On Neuromuscular And Bone Health: A Nutrition Focused Review

### Sibgha Shafqat\*

Department of Human Nutrition and Dietetics, Muhammad Nawaz Shareef University of Agriculture, Multan, Pakistan Email: dn.sibghashafqat@gmail.com

### Alishbah Mazhar

Department of Human Nutrition and Dietetics, Muhammad Nawaz Shareef University of Agriculture, Multan, Pakistan

### Shaheer Hamid

Department of Human Nutrition and Dietetics, Nishtar Medical University, Multan, Pakistan

### Asma Zaidi

Department of Human Nutrition and Dietetics, Muhammad Nawaz Shareef University of Agriculture, Multan, Pakistan

### Maryam Saeed Khan

Department of Human Nutrition and Dietetics, Nishtar Medical University, Multan, Pakistan

### Ushna Mubashir

Department of Human Nutrition and Dietetics, Nishtar Medical University, Multan, Pakistan

### Muhammad Hassan Tahir

Department of Human Nutrition and Dietetics, Nishtar Medical University, Multan, Pakistan

### Abstract

Magnesium is an important micronutrient which is a part of almost 300 enzymatic reactions in our body. It is needed for neuromuscular transmission, energy production, bone maintenance and immune system regulation. This makes an important topic because magnesium deficiency has slowly emerged as a worldwide public health concern. The dietary magnesium deficiency is mostly caused by modern lifestyle and dietary habits. Although severe deficiency is not common, long term deficiency can lead to chronic inflammation, a problem being faced by many adults worldwide. Existing research shows that magnesium plays a functional role in muscle contraction, nerve conduction, calcium metabolism and bone formation. Sufficient magnesium intake is linked with enhanced muscle and neurological function. It also strengthens our body's metabolic control and reduces the risk of cardiovascular diseases. However, there is debate regarding certain aspects of this topic, such as the role of serum magnesium, a biomarker, in the prevalence of magnesium deficiency. Also, there is little clarity regarding the effectiveness of

dietary intake versus supplementation in various health conditions. This review emphasizes current evidence on dietary magnesium deficiency, highlighting its

### Author Details

**Keywords:** Magnesium Deficiency; Neuromuscular Function; Calcium Metabolism; Chronic Inflammation; Energy Metabolism; Public Health Nutrition

Received on 13 Jan 2026

Accepted on 13 Feb 2026

Published on 23 Feb 2026

Corresponding E-mail & Author\*:

### Sibgha Shafqat\*

Department of Human Nutrition and Dietetics, Muhammad Nawaz Shareef University of Agriculture, Multan, Pakistan Email: dn.sibghashafqat@gmail.com

influence on neuromuscular health, bone metabolism and systemic inflammation. It also outlines populations at risk including elderly, pregnant and postmenopausal women and individuals with chronic health conditions. Moreover, the review focuses on dietary magnesium sources, its bioavailability, and also introduces certain nutritional strategies for reducing magnesium deficiency. Acknowledging and understanding magnesium deficiency is important because it is a nutritional factor which plays an important role in healthy aging and disease prevention.

## **Introduction**

Magnesium (Mg) is a mineral that plays certain role in the human physiology and is the second most common intracellular cation following potassium. It has high concentration in cells, about 99 percent of total body Mg, of which almost 50-65 percent is found in bone tissue, that's why its structural and metabolic value is quite important. The levels of magnesium raise rapidly at early stages, up to 20-28 g, after one's maturity; magnesium is vital in managing immunity and curbing inflammation. Poor stores are related to immune dysregulation and is a contributive factor to both acute and chronic inflammatory diseases, which underscores its systemic value beyond mineral homeostasis (Ashique et al., 2023). Magnesium, has been cited in 450-600 enzymatic reactions that govern all the important processes, such as oxidative phosphorylation, ATP production, protein and nucleic acid synthesis, and neuromuscular transmission. It promotes cardiovascular, nervous, and musculoskeletal system integrity as being a non-essential cofactor in signaling pathways. Although it has physiological impacts, Mg deficiency is a common health problem worldwide. Despite its frequent insufficiency in modern diets, the cause is mainly the nature of diet, rich in incomplete grains, legumes, and green vegetables (Fatima et al., 2024; Petho et al., 2024). Recent dietary guidelines indicate that 300-400 mg/day, Mg intake is adequate for adults, and varies with both age and sex. Though cereals and grain-based food products, recognized as the main sources in most of the populations, food produced by the animals like milk, milk products and meat are also contributing to its bioavailability, especially in at-risk population (children and older adults.) Nevertheless, the chronic magnesium intake turns out to be less than optimal level in most groups of population, because of decreased consumption of Mg-containing foods and increased use of processed ones, which contributes to latent or chronic deficiency state (Pinotti et al., 2021; Nielsen, 2024). As the body is capable of adjusting the levels by increasing the intestinal absorption and decreasing renal excretion, a sustained deficiency wears off bones and disrupts homeostatic balance. Magnesium deficiency is long-term, mild-to-moderate in its nature, resulting cardiovascular risks, being hard to detect because of such nonspecific clinical signs and restrictions of magnesium levels in the serum as a biomarker. Average serum magnesium levels are not always an accurate indicator of sufficient levels in the body, and early identification of deficiency is difficult (Nielsen, 2024; Rondanelli et al., 2021). Reduced magnesium has major effects on the neuromuscular activities, interfering with the conduction of nerves, muscle contractions and cell excitability. Severe deficiency can cause cramps in the muscles, tremors, tetany, arrhythmias and neuropsychiatric symptoms where chronic deficiency can lead to muscle weakness, fatigue and increased vulnerability. According to studies, the hypomagnesaemia worsens the oxidative stress and skeletal muscle homeostasis, contributing to the acceleration of muscle degeneration and functional deterioration (Pardo et al., 2021; Liguori et al., 2024). Studies also indicates that magnesium supplementation has the potential to increase muscle mass, reduce inflammation and neuromuscular soreness, especially in individuals with a reported deficiency or disease. These outcomes suggest that sufficient dietary intake is vital to ensure the neuromuscular health throughout the lifespan. (Liguori et al., 2024). Magnesium

influence bone metabolism that reduces the activity of osteoblasts and osteoclasts, which keeps the bones stiff and controls the concentrations of calcium and vitamin D. It also slows down bone formation, elevates bone resorption, and disrupts the secretion of parathyroid hormone (PTH) and vitamin D activation. (Rondanelli et al., 2021). The studies imply that the maternal magnesium status is very important in the fetal programming and lifetime skeletal and neuromuscular well-being, and it is important to ensure proper intake during the crucial developmental stages (Fanni et al., 2021). Unless magnesium deficiency in diet is uncommon, there ought to be nutritional policies focused on the precise and optimal consumption of magnesium-rich foods, which are available, rather than addressing dietary and pharmacological determinants that hinder its absorption or excessive urinary excretion. In case dietary intakes are not enough, magnesium supplements are selected carefully, they can provide a safe and effective strategy of restoring optimum magnesium status. Nevertheless, supplementation should not be resorted blindly to avoid possible side effects, which means that nutritional therapy must be personalized.

### **Dietary Magnesium Deficiency**

Magnesium (Mg) is the second most abundant intracellular cation where it plays a critical role in enzyme function and trans-membrane ion transport. (Rude et al., 2009). Deficient Magnesium status correlates with hypertension, type 2 diabetes, osteoporosis, migraine, depression, and chronic inflammation, in contrast, adequate intake supports skeletal strength, metabolic and neurological stability, and healthy aging. Magnesium deficiency appears to be widespread due to modern dietary patterns, chronic stress, usage of medicines, and certain health conditions. (Sarić et al., 2025). Undiagnosed Magnesium deficiency is frequently observed among the general population. Kidneys limit urinary excretion to avoid hypomagnesaemia, persistent low intakes or excessive losses, lead to subclinical deficiency. In high income societies, severe dietary deficiency is not common, but imbalanced diets such as high intakes of fat or calcium can exacerbate, especially under conditions of stress. Magnesium absorption, distribution, and retention are influenced by hormonal fluctuations especially variations in estrogen levels, consequently affecting homeostasis throughout various life stages such as puberty, pregnancy, and menopause. (Mazza et al., 2025). Magnesium play crucial roles in the immune system, nervous, and muscle systems. Acute Magnesium deficiency may cause medical encephalopathy, and alters neuromuscular excitability whereas chronic Mg deficiency is associated with spasm (Wenwen et al., 2019). In the brain, Magnesium is involved in diverse physiological and biochemical processes. It regulates the function of ion channels and neurotransmitter and blocks Ach release at neuromuscular junctions, also mediating several antiepileptic, antidepressant, anxiolytic, antimigraine, neuroprotective and analgesic effects. It also plays a key role in respiratory, neurological and cardiovascular physiology. Low magnesium status contributes to impaired bronchodilation, pressure, and cardiac impulse generation due to altered conduction by disrupted calcium regulators affecting smooth muscle dysfunction causing ionic and electrophysiological instability, and abnormal cardiac excitation and contraction. These consequences are modulated by calcium channel antagonism, changes in sodium potassium pump, and disruption of gap junctions in excitable tissues leading to breathing difficulties, muscle weakness, cardiac arrest. Chronic subclinical Magnesium deficiency is increasingly common in the general population. Disruption of Magnesium homeostasis alters transmembrane fluxes of other cations that lead to pathophysiological electro-genesis, which can be life threatening (Stanojević et al., 2024). Low Magnesium status has been associated with neurological dysfunction, particularly migraines. Magnesium modulates neuronal excitability through voltage-gated calcium antagonism and N-methyl-D-aspartate receptor blockade, thus reducing cortical spreading depression events and trigemino

vascular activation, both serve as primary mechanisms in brain. Observational studies have indicated lower circulating Magnesium concentration in migraine patients. However, findings may be affected by dietary patterns, sex differences, and uncontrolled confounding, which limit causal interpretation. (Sarić et al., 2025). Magnesium may be associated with disorders like Alzheimer’s disease, Parkinson’s disease, cerebral vasospasm, stroke, and particularly migraine.

Early signs of deficiency, often reflected in symptoms such as weakness, loss of appetite, fatigue, nausea and vomiting. Progression can result in muscle contractions and cramps, tingling, numbness, personality changes, abnormal heart rhythms, coronary spasms, and seizures in later stages. Severe deficiency leads to hypocalcemia or hypokalemia due to disruption of mineral homeostasis.

### Systemic Effects of Dietary Magnesium Deficiency

Magnesium deficiency is currently acknowledged as a contributor in chronic low-grade inflammation, which is responsible for development of many non-communicable diseases. Low Mg status may impair endothelial function and affect immune regulation, contributing to vascular and metabolic inflammatory processes. Reduced level activates inflammatory signaling, and this persistent inflammatory environment speeds up vascular injury and decline in cardio- metabolic health with time (Sarić et al., 2025). Due to Magnesium deficiency, stress unexpectedly elevates the risk of damage including hypertension, cerebrovascular and coronary constriction and occlusion, arrhythmias, sudden cardiac death (Seeling et al., 1994). Deficiency of both Vitamin D and Magnesium is associated with an increased risk of anemia in children (Gu et al.,2025).

Evidence indicates that Magnesium status is associated with cancer risk, progression, mortality, and drastic outcomes. Colorectal cancer may be most affected by Magnesium because the colon is directly exposed to luminal Magnesium, and interaction with microbiota may enhance its biological impact. Deficient Magnesium level has impaired DNA repair capacity and increasing lung cancer risk. Meta-analysis indicate that each additional 100mg/day increase in dietary Magnesium intake results, 5% reduction in cancer mortality (Sarić et al., 2025). Magnesium deficiency is associated with inflammation, cardiovascular disease, and cancer risk (Table 1).

**Table 1: Health Effects and Clinical Implications of Magnesium Deficiency**

<b>Health Domain</b>	<b>Mechanism / Biological Effect</b>	<b>Clinical or Disease Outcomes</b>	<b>Key Evidence / Notes</b>
<b>Chronic inflammation</b>	Promotes chronic low-grade inflammatory state	Contributes to development of non-communicable diseases	Linked to systemic inflammatory activation (Sarić et al., 2025)
<b>Endothelial function &amp; immune regulation</b>	Impairs endothelial function and alters immune responses	Vascular inflammation and metabolic dysfunction	Drives vascular and metabolic inflammatory processes
<b>Cardiometabolic health</b>	Activates inflammatory signaling pathways	Progressive vascular injury and cardiometabolic decline	Persistent inflammation worsens long-term cardiovascular health (Sarić et al.,

			2025)
<b>Stress-related cardiovascular damage</b>	Enhances stress-induced physiological damage	Hypertension, cerebrovascular constriction, coronary occlusion, arrhythmias, sudden cardiac death	Increased cardiovascular vulnerability under stress (Seeling et al., 1994)
<b>Nutritional deficiency interaction</b>	Combined deficiency with vitamin D affects hematologic function	Increased risk of anemia in children	Synergistic nutrient deficiency effect (Gu et al., 2025)
<b>Cancer risk and outcomes (general)</b>	Influences cellular regulation and survival pathways	Affects cancer risk, progression, and mortality, severity	Overall magnesium status linked with cancer outcomes
<b>Colorectal cancer</b>	Direct luminal exposure of colon to magnesium; microbiota interaction	Stronger biological influence on colorectal cancer risk	Colon exposure may amplify magnesium's protective or harmful effects
<b>Lung cancer</b>	Impaired DNA repair capacity when magnesium is low	Increased lung cancer risk	Reduced genomic stability associated with deficiency
<b>Cancer mortality (dietary intake)</b>	Higher intake improves physiological resilience	Reduced cancer mortality	Each additional 100 mg/day dietary magnesium associated with ~5% reduction in cancer mortality (Sarić et al., 2025)

### **Role of dietary Magnesium in Bone Health and Metabolism**

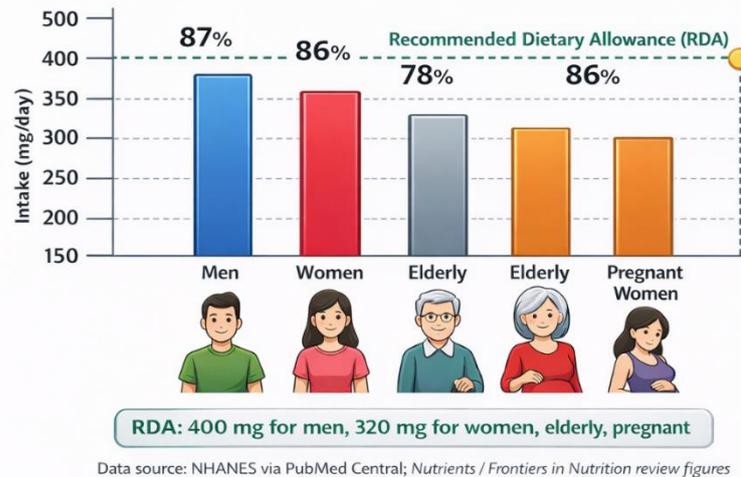
Mg has major roles in metabolism of body including 300 enzymatic reaction in which it acts as cofactor. It regulates metabolic pathway in all phosphorylation processes that involve in ATP-driven energy utilization. In the biochemical process of contraction Mg does not involve directly, but effects the Ca ion concentration and its availability. It competes on Ca binding site inside the cell and turns it toward relaxation. For muscle relaxation SERCA pump removes Calcium, which again need Mg for ATP production (Xu et al., 2021). Mg is one of the major micro minerals that have regulating and synthetic role in the body. It is falsely considered as bone forming mineral only but it plays a core regulatory role in many other processes such as electrolyte balance, maintenance of bone health, metabolism, neurotransmission, muscle contraction and protein synthesis. (Erem et al., 2019). In elaborating role of dietary magnesium in bone health and metabolism, it affects bone in a couple of ways. Directly it helps in decreasing osteoblast activity, making new bone cells and making them strong and less fragile. On the other side, it hinders the parathyroid and vitamin

D activation that result in elevation of oxidative stress and bone loss (Castiglioni et al., 2013). Magnesium role in vitamin D synthesis and activation is also considerable which in turn increase absorption of magnesium through intestine and maintains homeostasis (Uwitonze and Razzaque 2018; Erem et al., 2019). Small intestine absorbs 30-50% of magnesium of the total amount taken. Serum level ranges from 1.7-2.3mg/dl considerably at all stages of life. Only 3 % is excreted in urine but fluctuated levels are seen in osteoporosis, nephrolithiasis, aplastic osteopathy, diabetes mellitus, chronic renal failure, heart and vascular diseases. In pathological state Mg deficiency occur when there is decreased intestinal absorption, or more losses through urine, or intracellular shift of its cation. This loss is compensated intravenous or by IV, other than that Anti-kaliuretic diuretics that also saves Mg. Hyper-magnesemia may occur in renal insufficiency or due to excessive intake (Musso, 2009). Mg deficiency leads to osteoporosis that is more common in postmenopausal women and older adults. Bone mineral density and Mg levels are correlated, and investigation occur in postmenopausal osteoporotic women compared to 81 healthy (non-osteoporotic) women that were also in post-menopausal phase. Mg level was significantly less in post-menopausal osteoporotic women as then to control group ( $1.76 \pm 0.06$  mg/dl compared to  $2.14 \pm 0.14$  mg/dl) (Mederle et al., 2018).

There was analysis on serum level of different minerals including Magnesium and its link with osteoporosis. The results showed significant relation between low serum magnesium level, presence of both lumbar (L1-L4) and osteoporosis femoral. The women of age 45 to 59 years, 47.1% have osteoporotic women at the level of L1-L4 while 29.4% of osteoporotic women at the level of the whole femur. Similarly, 32.4% of osteoporotic women at the neck of the femur and they are having serum Mg value lower than the reference range (Okayay et al., 2013). Magnesium has important physiological role in insulin metabolism. It helps in secretion and activation of insulin. Mg act as a cofactor in activation of tyrosine kinase, insulin receptor substrates 1, insulin receptor substrates 2, phosphatidylinositol 3-kinase, and protein kinase B that helps to bind insulin effectively and initiate intracellular signaling. It also effects the activity of intracellular protein that involve insulin secretion from beta cells, such as glucokinase, ATPase, and protein kinase C (de Sousa Melo et al., 2022). That's why lack of dietary Mg directly affects the conversion of glucose into glucose-6-phosphate along with inhibiting pancreatic beta cell depolarization, leading to impaired glucose metabolism, insulin resistance. Adding the dietary supplements of Magnesium helps to lower the fasting blood glucose, improving insulin sensitivity and minimize the risk of type 2 diabetes mellitus (Kostov et al., 2019).

### **Populations at risk of Dietary Magnesium Deficiency**

Although magnesium has essential roles, its deficiency is recognized as a pressing but underappreciated public health concern worldwide, hyped by suboptimal dietary intake, aging, chronic conditions, medications, and lifestyle factors. Recent studies suggest that certain populations are disproportionately marked as low magnesium status, which has downstream effects elevating magnesium requirements (Fig. 1) (Saric et al., 2025).

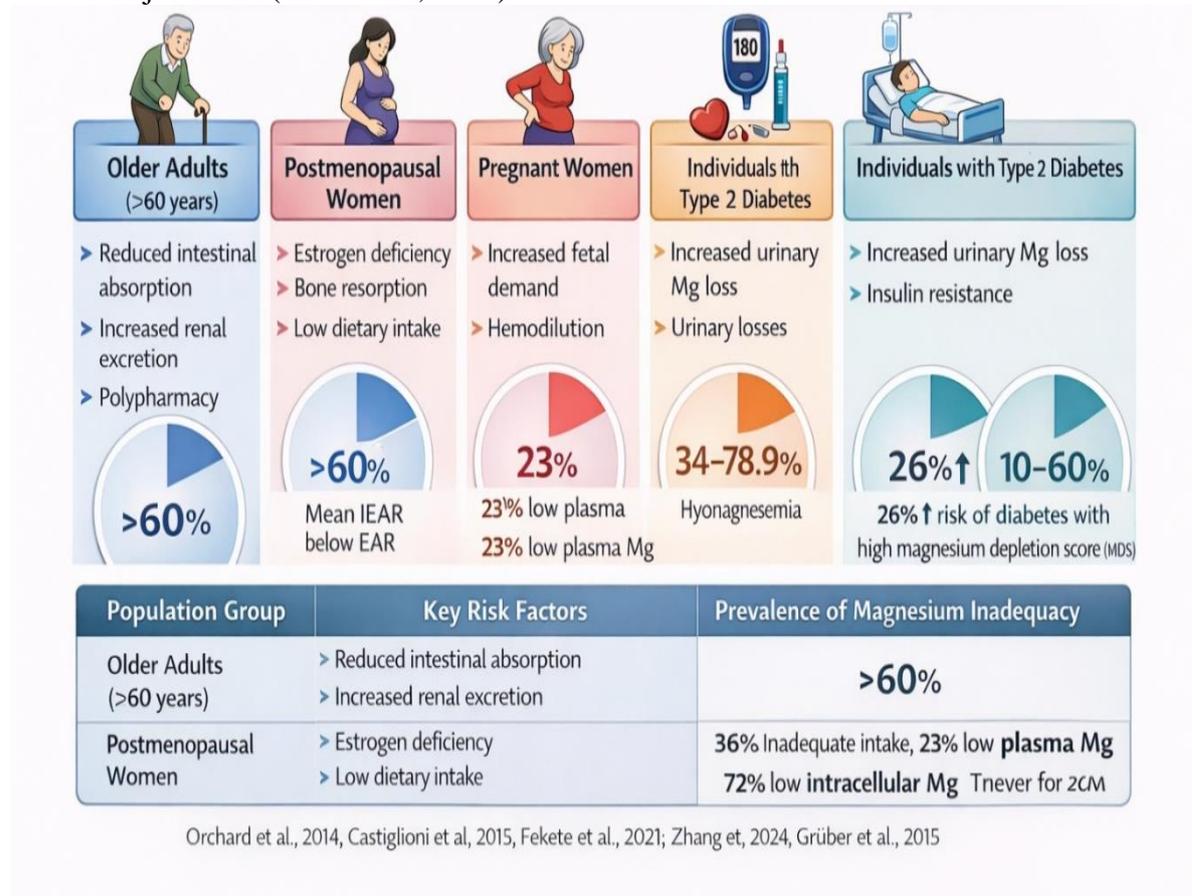


**Fig 1:**

The disparity between RDA and magnesium intake among different populations. Analyses show that adult men consume ~370–380 mg/day of magnesium, achieving 87% of the RDA (400 mg/day), while women meet about 86% of their recommended intake (~350 mg/day vs. RDA 320 mg/day). On the other hand, elderly populations exhibit lower intakes (78–86% of the RDA). Pregnant women show the greatest relative deficiency, (300 mg/day, corresponding ~86% of the recommended level). This persistent fall intake among vulnerable populations is clinically significant underscoring magnesium deficiency as a prevalent yet neglected public health issue, especially among elderly and pregnant women, warranting tailored nutritional interventions and dietary guidance. (Ford & Mokdad, 2003; Wang et al., 2022). Ageing contributes to magnesium deficit. Primary magnesium losses originate from two etiological factors: deficiency and depletion. Magnesium deficit in ageing mainly results from pathological and physiological conditions common to elderly people, participating in the clinical pattern of neuromuscular, cardiovascular, and renal symptomologies. Institutionalized individuals often display marked deficiencies compared to free-living counterparts due to reduced intestinal absorption, increased renal excretion, and the prevalence of comorbidities that influence magnesium metabolism. (Durlach et al., 1998). Pregnancy raises magnesium demands due to fetal growth and frequent renal excretion. Population studies revealed that high prevalence of hypomagnesemia among pregnant women, with up to 34–78.9% meeting deficiency thresholds contingent on serum cut-offs. Women with hormone-related syndromes also demonstrate high rates of low magnesium status; age and BMI further temper the risk. During menopause, weight gain and bone loss occurs due to the hormonal decline, suggests a risk factor for obesity and osteoporosis. Magnesium deficiency may also be linked to various other aspects of women's health, such as the use of oral contraceptives. (Orlova et al., 2021). Even ~36% of postmenopausal women have not enough magnesium intake, while 23% have low plasma magnesium and 72% exhibit low intracellular (erythrocyte) magnesium, highlighting the gap between serum and body Mg stores due to estrogen-mediated changes in bone metabolism. (Lopez et al., 2014). Altered magnesium depletion scores (MDS) (an index predicting magnesium insufficiency) – significantly associated with diabetes prevalence. (Tian et al., 2024). Hospitalized populations (especially in ICUs) with cardiovascular issues, chronic kidney disease, or gastrointestinal disorders incline to have higher chances of hypomagnesemia due to adjusted renal handling, dietary restriction, or drug interactions (e.g., diuretics, PPIs). (Fang et al., 2016).

## Population with Low Socioeconomic Status

Studies report that most adults do not intake the recommended magnesium dose, with ~50–60% of US adults falling below the average need. Significantly, the persistence of magnesium insufficiency in low-income as compared to high-income settings persuades that the problem is not solely dietary but reveals broader structural flaws of food systems and income patterns. Lower socioeconomic status, poorer diet quality, and diets high in processed foods are associated with lower magnesium that increases the risk of deficiency expanding vulnerability to cardio metabolic and inflammatory disease trajectories. (Saric et al., 2025).



**Fig 2:** The prevalence of magnesium inadequacy in augmented nutritional risk populations

This figure shows that older adults (>60 years) disclose the highest prevalence, ~60%, mainly due to reduced intestinal absorption, increased renal excretion, and polypharmacy. Postmenopausal women also show overburden, with ~60% consuming magnesium below the Estimated Average Requirement, followed by a major proportion with low plasma and intracellular magnesium concentrations. For pregnant women, ~23% demonstration of low plasma magnesium levels, indicating increased fetal demands, hemodilution, and insufficient dietary intake. Individuals with type 2 diabetes showcase another vulnerable population, with prevalence, ~34% to 78.9%, primarily driven by urinary magnesium losses, secondary to hyperglycemia and insulin resistance. Particularly, elevated magnesium depletion scores correlates with 10–60% prevalence of magnesium inadequacy.

## Nutrition Therapy, Dietary Strategies, and Future Directions

Mg is the fourth most abundant element in the human body. The human body at birth contains 760 mg of Mg, quantity increases to 5g as the age progresses to 5 months. (Seo et al., 2023). The sources of Mg include legumes, seeds, nuts (such as almonds, Brazil nuts, cashews, and peanuts), cereals (like and millet and brown rice) and whole-grain breads as well as various cocoa and fruits, which are known as the

magnesium best sources (Romani, 2011). Mg is a trace mineral and is not abundantly found in nature, but is mostly present in plant foods such as pumpkin seeds, almonds, black beans, etc (Oso & Ashafa, 2021). Green leafy foods are usually considered as magnesium rich foods in terms of hypothesis that magnesium bound in chlorophyll can be a substantial source of magnesium (Bohn et al., 2004). The Mg intake at different ages in different according to the body's needs. There is an exceptionally significant role of milk in magnesium consumption in very young and elderly people, who are more susceptible to poor nutrition and may take advantage of high bioavailability of magnesium present in milk. Moreover, a number of research report that lactose found in dairy products can enhance magnesium absorption in the intestines of child infants (Pinotti et al., 2021). The fermentation of lactose in the ileum has been attributed to the better absorption of magnesium as it reduces the local pH. This acidic condition reduces the precipitation of insoluble calcium magnesium phosphate complex, thus increasing the absorption of magnesium in the ileum (Cazzola et al., 2020). The Dietary Reference Intake (DRI) of nutrients varies as we move from one continent to another. The NIH (National Institute of Health) of the United States represents that the DRI of Mg for the age group 30-50 years is 420mg/day for men and 320mg/day for women, and almost 48% of Americans consume less Mg than the DRI. ("Office of Dietary Supplements - Magnesium"). As we move down to Korea, the DRI for the age group 30-50 years is 370mg/day for men and 280mg/day for women. (Kim et al., 2022). Mg plays an important role in enhancing sleep quality and overall mental health. A dosage of 200-400 mg per day has been studied to enhance the quality of sleep and reduce the symptoms of anxiety and depression. Mg plays a pivotal role in Ca metabolism and maintaining bone density. A supplementation period usually takes between 4 to 12 months and it is necessary to go through with a healthcare professional prior to starting any supplementation program to determine the right amount of supplement depending on personal health condition and dietary consumption (Fatima et al., 2024). Sarcopenia is a disorder most commonly described as the progressive loss of muscle mass and strength that is resulting with the age (Cruz-Jentoft et al., 2019). As per the recent research of Mg and bone mineralization, it is also emerging that there is a linkage between Mg and maintenance and functionality of skeletal muscle (Dominguez et al., 2006).

## **CONCLUSION:**

Magnesium deficiency is an important yet often overlooked nutritional problem. It has serious and wide-ranging implications on human health. Sufficient magnesium intake is important as it is a key regulator of neuromuscular and bone health. It is important for maintaining physiological balance across human life span. This review paper shows that chronic magnesium deficiency can lead to dysfunctional neuromuscular coordination, reduced bone strength and imbalance metabolism. It increases disease susceptibility especially in elderly, pregnant and postmenopausal women and people with chronic diseases. The inability to accurately evaluate magnesium status further makes it difficult to timely detect and treat the deficiency. Nutritional guidance and strategies that focus on prioritizing consumption of magnesium rich foods can help reduce deficiency related disorders. In case of insufficient dietary intake supplementary support should be given. Research on magnesium deficiency provides us with cost effective ways to timely detect the deficiency and prevent any long-term complications. Thus, it helps in improving overall population health and nutritional status.

## **References**

Ashique, S., Kumar, S., Hussain, A., Mishra, N., Garg, A., Gowda, B. H. J., Farid, A., Gupta, G., Dua, K., & Taghizadeh-Hesary, F. (2023). A narrative review on

- the role of magnesium in immune regulation, inflammation, infectious diseases, and cancer. *Journal of Health, Population and Nutrition*, 42(1), 74. <https://doi.org/10.1186/s41043-023-00423-0>
- Bohn, T., Walczyk, T., Leisibach, S., & Hurrell, R. F. (2004). Chlorophyll-bound Magnesium in Commonly Consumed Vegetables and Fruits: Relevance to Magnesium Nutrition. *Journal of Food Science*, 69, S347–S350. <https://doi.org/10.1111/j.1365-2621.2004.tb09947.x>
- Cazzola, R., Della Porta, M., Manoni, M., Iotti, S., Pinotti, L., & Maier, J. A. (2020). Going to the roots of reduced magnesium dietary intake: A tradeoff between climate changes and sources. *Heliyon*, 6(11), e05390. <https://doi.org/10.1016/j.heliyon.2020.e05390>
- Cruz-Jentoft, A. J., Bahat, G., Bauer, J., Boirie, Y., Bruyère, O., Cederholm, T., Cooper, C., Landi, F., Rolland, Y., Sayer, A. A., Schneider, S. M., Sieber, C. C., Topinkova, E., Vandewoude, M., Visser, M., & Zamboni, M. (2019). Sarcopenia: revised European consensus on definition and diagnosis. *Age Ageing*, 48(1), 16–31. <https://doi.org/10.1093/ageing/afy169>
- Dominguez, L. J., Barbagallo, M., Lauretani, F., Bandinelli, S., Bos, A., Corsi, A. M., Simonsick, E. M., & Ferrucci, L. (2006). Magnesium and muscle performance in older persons: the InCHIANTI study. *Am J Clin Nutr*, 84(2), 419–426. <https://doi.org/10.1093/ajcn/84.1.419>
- Fatima, G., Dzupina, A., H, B. A., Magomedova, A., Siddiqui, Z., Mehdi, A., & Hadi, N. (2024). Magnesium Matters: A Comprehensive Review of Its Vital Role in Health and Diseases. *Cureus*, 16(10), e71392. <https://doi.org/10.7759/cureus.71392>
- Kim, H., Hwang, J. Y., & Kwon, O. (2022). Dietary Reference Intakes for Koreans with special consideration to older adults. *Nutr Res Pract*, 16(Suppl 1), S1–s10. <https://doi.org/10.4162/nrp.2022.16.S1.S1>
- Office of Dietary Supplements - Magnesium.
- Oso, A. A., & Ashafa, A. O. (2021). Nutritional composition of grain and seed proteins. In *Grain and seed proteins functionality*. IntechOpen.
- Pinotti, L., Manoni, M., Ferrari, L., Tretola, M., Cazzola, R., & Givens, I. (2021). The Contribution of Dietary Magnesium in Farm Animals and Human Nutrition. *Nutrients*, 13(2). <https://doi.org/10.3390/nu13020509>
- Romani, A. M. (2011). Cellular magnesium homeostasis. *Arch Biochem Biophys*, 512(1), 1–23. <https://doi.org/10.1016/j.abb.2011.05.010>
- Seo, S., Kim, M., Yang, E., & Yang, M. (2023). Safe Application of Magnesium Supplement for Precision Nutrition. *Food Suppl Biomater Health*, 3(3).
- Young, D., Book, M., Shows, R., & Zinc, I. T. M. V. US Adult RDA: 400–1000 mg/Day Therapy Dose Range: 500–2000 mg/Day.
- Matek Saric, M., Sorić, T., Juko Kasap, Ž., Lisica Šikić, N., Mavar, M., Andruškienė, J., & Saric, A. (2025). Magnesium: Health Effects, Deficiency Burden, and Future Public Health Directions. *Nutrients*, 17(22), 3626. <https://doi.org/10.3390/nu17223626>
- Ford, E. S., & Mokdad, A. H. (2003). Dietary magnesium intake in a national sample of U.S. adults. *The Journal of Nutrition*, 133(9), 2879–2882. <https://doi.org/10.1093/jn/133.9.2879>
- Wang, J., Xing, F., Sheng, N., & Xiang, Z. (2022). Associations of dietary magnesium intake and magnesium depletion score with osteoporosis: Evidence from NHANES 2005–2018. *Frontiers in Nutrition*, 9, 883264. <https://doi.org/10.3389/fnut.2022.883264>
- Durlach, J., Bac, P., Durlach, V., Rayssiguier, Y., Bara, M., & Guet-Bara, A. (1998). Magnesium status and ageing: an update. *Magnesium Research*, 11(1), 25–42.

- López-González, B., Molina-López, J., Florea, D. I., Quintero-Osso, B., Pérez de la Cruz, A., & Planells del Pozo, E. M. (2014). Association between magnesium-deficient status and anthropometric and clinical-nutritional parameters in postmenopausal women. *Nutricion Hospitalaria*, 29(3), 658–664. <https://doi.org/10.3305/nh.2014.29.3.7198>
- Tian, Z., Qu, S., Chen, Y., Fang, J., Song, X., He, K., Jiang, K., Sun, X., Shi, J., Tao, Y., & Jin, L. (2024). Associations of the magnesium depletion score and magnesium intake with diabetes among US adults: an analysis of the National Health and Nutrition Examination Survey 2011-2018. *Epidemiology and health*, 46, e2024020. <https://doi.org/10.4178/epih.e2024020>
- Fang, X., Wang, K., Han, D., He, X., Wei, J., Zhao, L., Imam, M. U., Ping, Z., Li, Y., Xu, Y., Min, J., & Wang, F. (2016). Dietary magnesium intake and the risk of cardiovascular disease, type 2 diabetes, and all-cause mortality: a dose-response meta-analysis of prospective cohort studies. *BMC Medicine*, 14(1), 210. <https://doi.org/10.1186/s12916-016-0742-z>
- Orchard, T. S., Larson, J. C., Alghothani, N., Bout-Tabaku, S., Cauley, J. A., Chen, Z., ... Wactawski-Wende, J. (2014). Magnesium intake, bone mineral density, and fractures: Results from the Women's Health Initiative Observational Study. *The American Journal of Clinical Nutrition*, 99(4), 926–933. <https://doi.org/10.3945/ajcn.113.067488>
- Castiglioni, S., et al. (2015). Magnesium deficiency and osteoporosis: A narrative review. *Clinical Cases in Mineral and Bone Metabolism*, 12(1), 22–26.
- Fekete, K., Berti, C., Cetin, I., & Hermoso, M. (2021). Prevalence and determinants of hypomagnesemia in pregnancy: A systematic analysis. *BMC Pregnancy and Childbirth*, 21, 76. <https://doi.org/10.1186/s12884-021-03558-2>
- Zhang, Y., Xun, P., Wang, R., Mao, L., & He, K. (2024). Magnesium depletion score and risk of diabetes among U.S. adults: NHANES 2011–2018. *Nutrients*, 16(4), 512. <https://doi.org/10.3390/nu16040512>
- Rondanelli, M., Faliva, M. A., Tartara, A., Gasparri, C., Perna, S., Infantino, V., ... & Peroni, G. (2021). An update on magnesium and bone health. *Biometals*, 34(4), 715-736.
- Groenendijk, I., van Delft, M., Versloot, P., van Loon, L. J., & de Groot, L. C. (2022). Impact of magnesium on bone health in older adults: A systematic review and meta-analysis. *Bone*, 154, 116233.
- Palacios, C. (2006). The role of nutrients in bone health, from A to Z. *Critical reviews in food science and nutrition*, 46(8), 621-628.
- Fatima, G., Dzupina, A., Alhmadi, H. B., Magomedova, A., Siddiqui, Z., Mehdi, A., ... & RAZA, A. M. (2024). Magnesium matters: A comprehensive review of its vital role in health and diseases. *Cureus*, 16(10).
- Barbagallo, M., & Dominguez, L. J. (2007). Magnesium metabolism in type 2 diabetes mellitus, metabolic syndrome and insulin resistance. *Archives of biochemistry and biophysics*, 458(1), 40-47.
- Musso, C. G. (2009). Magnesium metabolism in health and disease. *International urology and nephrology*, 41(2), 357-362.
- de Sousa Melo, S. R., Dos Santos, L. R., da Cunha Soares, T., Cardoso, B. E. P., da Silva Dias, T. M., Morais, J. B. S., ... & do Nascimento Marreiro, D. (2022). Participation of magnesium in the secretion and signaling pathways of insulin: an updated review. *Biological trace element research*, 200(8), 3545-3553.
- Lee, S. H., Park, S. Y., & Choi, C. S. (2022). Insulin resistance: from mechanisms to therapeutic strategies. *Diabetes & metabolism journal*, 46(1), 15-37.
- Kostov, K. (2019). Effects of magnesium deficiency on mechanisms of insulin resistance in type 2 diabetes: focusing on the processes of insulin secretion and signaling. *International journal of molecular sciences*, 20(6), 1351.

- Seelig, M. S. (1994). Consequences of magnesium deficiency on the enhancement of stress reactions; preventive and therapeutic implications (a review). *Journal of the American College of Nutrition*, 13(5), 429–446. <https://doi.org/10.1080/07315724.1994.10718432>
- Rude, R. K., Singer, F. R., & Gruber, H. E. (2009). Skeletal and Hormonal Effects of Magnesium Deficiency. *Journal of the American College of Nutrition*, 28(2), 131–141. <https://doi.org/10.1080/07315724.2009.10719764>
- Wenwen, R., Jing, Y., Yingchao, S., & Qinglu, W. (2019). The Effect of Magnesium Deficiency on Neurological Disorders: A Narrative Review Article. *Iran J Public Health*, 48(3), 379–387. <https://share.google/Cxsk1skNOfuBUTg8z>
- Stanojević, M., Djuricic, N., Parezanovic, M., Biorac, M., Pathak, D., Spasic, S., Lopovic, S., Kovacevic, S., & Ostojic, J. N. (2024). The Impact of Chronic Magnesium Deficiency on Excitable Tissues—Translational Aspects, 203, 707–728.
- Mazza, E., Maurotti, S., Ferro, Y., Castagna, A., Pujia, C., Sciacqua, A., Pujia, A., & Montalcini, T. (2025). Magnesium: Exploring Gender Differences in Its Health Impact and Dietary Intake, 17(13), 2226.
- Sarić, M. M., Sorić, T., Kasap, Z. J., Šikić, N. L., Mavar, M., Andruškienė, J., & Sarić, A. (2025). Magnesium: Health Effects, Deficiency Burden, and Future Public Health Directions, 17(22), 3626.
- Gu, W., Wang, Y., Li, C., Wu, S., Liu, S., Chang, C., & Xue, L. (2025). Dietary magnesium intake as modifier of the association between vitamin D deficiency and risk of anemia in the US children aged 2-14 years: A cross-sectional study. *Medicine*, 104(50), e46264. <https://doi.org/10.1097/MD.00000000000046264>
- Castiglioni, S., Mazur, A. And Maier, J. A. (2024). The Central Role of Magnesium in Skeletal Muscle: From Myogenesis to Performance. *Magnesium Research*, 37(1), 1-11. <https://doi.org/10.1684/mrh.2024.0526>.
- Ashique, S., Kumar, S., Hussain, A., Mishra, N., Garg, A., Gowda, B. J., & Taghizadeh-Hesary, F. (2023). A narrative review on the role of magnesium in immune regulation, inflammation, infectious diseases, and cancer. *Journal of Health, Population and Nutrition*, 42(1), 74.
- Fatima, G., Dzupina, A., Alhadi, H. B., Magomedova, A., Siddiqui, Z., Mehdi, A., & Raza, A. M. (2024). Magnesium matters: A comprehensive review of its vital role in health and diseases. *Cureus*, 16(10).
- Pethő, Á. G., Fülöp, T., Orosz, P., & Tapolyai, M. (2024). Magnesium is a vital ion in the body—it is time to consider its supplementation on a routine basis. *Clinics and Practice*, 14(2), 521–535.
- Pinotti, L., Manoni, M., Ferrari, L., Tretola, M., Cazzola, R., & Givens, I. (2021). The contribution of dietary magnesium in farm animals and human nutrition. *Nutrients*, 13(2), 509.
- Nielsen, F. H. (2024). The role of dietary magnesium in cardiovascular disease. *Nutrients*, 16(23), 4223.
- Maier, J. A., Castiglioni, S., Locatelli, L., Zocchi, M., & Mazur, A. (2021). Magnesium and inflammation: Advances and perspectives. *Seminars in Cell & Developmental Biology*, 115, 37–44.
- Fanni, D., Gerosa, C., Nurchi, V. M., Manchia, M., Saba, L., Coghe, F., & Faa, G. (2021). The role of magnesium in pregnancy and in fetal programming of adult diseases. *Biological Trace Element Research*, 199(10), 3647–3657.
- Pardo, M. R., Vilar, E. G., Martín, I. S. M., & Martín, M. A. C. (2021). Bioavailability of magnesium food supplements: A systematic review. *Nutrition*, 89, 111294.
- Rondanelli, M., Faliva, M. A., Tartara, A., Gasparri, C., Perna, S., Infantino, V., & Peroni, G. (2021). An update on magnesium and bone health. *Biometals*, 34(4), 715–736.

- Liguori, S., Moretti, A., Paoletta, M., Gimigliano, F., & Iolascon, G. (2024). Role of magnesium in skeletal muscle health and neuromuscular diseases: A scoping review. *International Journal of Molecular Sciences*, 25(20), 11220.
- Xu, H., & Van Remmen, H. (2021). The SarcoEndoplasmic Reticulum Calcium ATPase (SERCA) pump: a potential target for intervention in aging and skeletal muscle pathologies. *Skeletal muscle*, 11(1), 25.