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The Benefits of Magnesium

Veena Abraham*, BSc (Biological Sciences), BSc (Hons) Pharmacology
Natalie Schellack**, BCur, BPharm, PhD (Pharmacy)

*Lecturer, Department of Pharmacy, Faculty of Health Sciences, Sefako Makgatho Health Sciences University (SMU)
**Associate Professor, Department of Pharmacy, Faculty of Health Sciences, Sefako Makgatho Health Sciences University (SMU)

Correspondence to: Prof Natalie Schellack, natalie.schellack@smu.ac.za

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Abstract

Magnesium (Mg^{2+}) is an essential ion for general well-being. After potassium it is the most abundant ion in the body and is responsible in enzymatic reactions especially for energy metabolism and protein synthesis. Imbalances in the overall magnesium status may lead to hypomagnesaemia or hypermagnesaemia; both of these can lead to untoward effects in cardiac, nervous or neuromuscular disorders. This article provides a brief overview on the physiological function of magnesium in the body and different indications where it may be used.

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Introduction

Magnesium (Mg^{2+}) is a multivalent cation and an essential electrolyte, necessary for the functioning of nearly all the organ systems in the human body. It serves as a cofactor for more than three hundred enzymes in the body and, as such, controls varied biochemical reactions as energy metabolism, protein synthesis, and neuromuscular impulse transmission.[1] Furthermore, Mg^{2+} is important in regulating the physiological functions of the brain, heart and skeletal muscles; it also acts as a calcium (Ca^{2+}) antagonist, and has anti-inflammatory properties. Magnesium is mainly distributed between the bone, muscle and soft tissues. Less than 1% is found in red blood cells.[2,3] A normal, balanced diet should provide adequate amounts of Mg^{2+}, with its dietary sources including seeds, nuts, legumes, dark green vegetables and unprocessed cereals.[1,4,5] It is worth noting that foods that undergo excessive refining and processing have substantially lower levels of magnesium than unrefined foods.[1,6] With the increasing consumption of processed foods, the average dietary intake of magnesium is declining[1,3] with estimates that the daily intake has decreased over the last 100 years, from about 500 mg per day to between 175 and 225mg per day.[5,7,8]

Table I shows the recommended daily dietary allowance of Mg^{2+} by age group.

Table I: Recommended dietary allowance (RDA) of Mg^{2+} in mg per day[1,4,7]

Age	Amount in mg/day	
Infants		
0-6 months	30 (AI) *	
6-12 months	75 (AI) *	
Children		
1-3 years	80	
4-8 years	130	
9-13 years	240	
Adults		
19-30 years	400 (males)	310 (females)
> 30 years	420 (males)	320 (females)
During pregnancy		
< 18 years	400	
19-30 years	350	
31-50 years	360	
Breastfeeding women		
< 18 years	360	
19-30 years	310	
31-50 years	320	

*Intake for infants up to 12 months of age are given as so-called adequate intakes (AIs), based on data from breastfed babies, as opposed to RDAs.

Functions of magnesium

Magnesium has an important role to play in nearly all physiological functions, including the regulation of many bodily functions through its action as a cofactor for numerous enzyme systems. Magnesium is necessary for the structural function of proteins, nucleic acids and the mitochondria, and is required for both aerobic and anaerobic energy production. It also plays a crucial role in the transport of Ca^{2+} and potassium across cell membranes. Magnesium is often considered as a calcium antagonist; it also regulates energy and stabilises membranes within the body.[9]

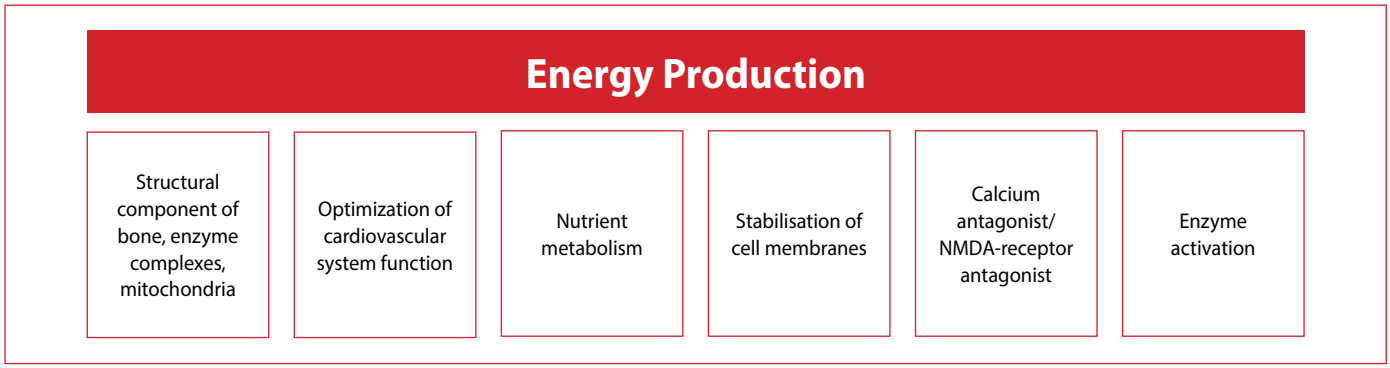

Figure 1: The main functions of magnesium

Magnesium is essential for the regulation of muscular contraction, blood pressure and insulin metabolism.[7] The main functions of magnesium are summarised in Figure 1.

Clinical benefits of magnesium

Due to the multitude of roles that magnesium plays in the body, it is involved in the prevention and treatment of many conditions, including preeclampsia, migraine, depression, coronary artery disease and asthma.[7,10]

Magnesium in the brain

Low serum and cerebrospinal fluid (CSF) levels of magnesium are found in neurological diseases such as migraine, epilepsy and depression. The use of magnesium as second-line therapy for patients with migraines has been studied extensively; however, the effectiveness of magnesium supplementation is debatable. That having been stated, there have been numerous studies that have found evidence of a beneficial effect of oral magnesium supplementation on the number of migraine attacks, as well as the intensity of the pain during these attacks.[10]

Magnesium produces depressant effects at synapses and is often used as an anticonvulsant.[7,11] Magnesium acts as an anticonvulsant by blocking the NMDA receptor and by reducing cerebral oedema.[10] This mechanism is also proposed for how magnesium works in patients with depression.[10] Furthermore, there is evidence that suggests that magnesium supplementation could be of some benefit to patients with Parkinson's disease.[10]

Magnesium and skeletal muscle

In sports medicine, magnesium increases skeletal muscle workload duration and enhances membrane function.[11]

Magnesium and the respiratory system

Magnesium may be used in the management of asthma due to the fact that it antagonises bronchospasm.[11] Magnesium has a strong vasodilatory and bronchodilator effect; it also inhibits the release of histamine and acetylcholine, and has anti-inflammatory effects.[3,8,10]

Magnesium and the heart

Magnesium plays a vital role in cardiovascular function by regulating calcium homeostasis, peripheral vascular resistance, vascular tone and cardiac output.[10] Mg^{2+} affects the electrical properties of the heart muscle by regulating ion channel activity. It also influences calcium mobility,[8] thus regulating the contractility of the heart. As mentioned previously, magnesium also has anti-inflammatory and vasodilatory effects, which may be beneficial to cardiac function.[10] Magnesium supplementation may be used to treat patients with myocardial infarction, arrhythmias and cardiac surgery.[11]

Magnesium in pregnancy

Magnesium has been used in the management of both pre-eclampsia and eclampsia since the 1950s[11] and this indication is promoted by the World Health Organization.[10] The beneficial effects of magnesium in these conditions may be attributed to the vasodilator effects of magnesium, but it is also important to note that the mechanism could be due to NMDA receptor blockade as well.[3,10] Magnesium is also used as a tocolytic agent.[3]

Magnesium in diabetes mellitus type 2

It has been shown that magnesium improves insulin sensitivity in individuals at risk for diabetes and that magnesium levels may influence the onset and development of diabetes mellitus type 2.[6,10] Thus, there may be a potential for magnesium supplementation in achieving glycaemic control in diabetic patients.

Hypomagnesaemia

Hypomagnesaemia is defined as a serum magnesium concentration < 0.75 mmol/L.[7] Magnesium deficiency occurs as a result of either insufficient dietary intake or excessive depletion, and may contribute to neuromuscular, cardiovascular and renal complications, amongst others.[1,9] The coexistence of other electrolyte abnormalities contributes to the clinical features of hypomagnesaemia.[3] Deficiency is associated with an increased risk of hypertension, atherosclerosis, arrhythmias, insulin resistance and osteoporosis. Early symptoms of magnesium deficiency include appetite loss, nausea and vomiting, and muscle

weakness.[1,2] Symptoms of increased neuromuscular excitability, such as tremor, muscle cramps and tetany, are found with more pronounced magnesium deficiency. Magnesium deficiency may also be the result of medication use. Examples of medications that may cause magnesium deficiency include the aminoglycosides, bisphosphonates, loop diuretics and proton pump inhibitors.[7] Oral magnesium supplementation may be used to manage hypomagnesaemia, intravenous magnesium should only be used for immediate correction in patients with severe cases or in patients with ventricular arrhythmias.[2]

Hypermagnesaemia

Hypermagnesaemia has quite a rare occurrence, but is well-documented in renal impaired patients taking magnesium-containing antacids, laxatives, enemas or certain intravenous infusions.[3,12] The most identified sign of hypermagnesaemia is the disappearance of deep tendon reflexes. Other symptoms include nausea and vomiting, facial flushing, hypotension, respiratory depression and bradycardia.[12,13] The management of hypermagnesaemia includes ceasing the intake of magnesium-containing medications or magnesium replacement therapy and supportive therapy.[2] Intravenous calcium gluconate will antagonize the toxic effects of magnesium in severe cases of toxicity.[3,12]

Conclusion

The clinical role of magnesium has been well established in obstetrics and its role in cardiology is becoming more prominent. Magnesium deficiencies may be associated with cardiovascular diseases, and other conditions such as metabolic syndrome and diabetes mellitus. Improvements in the measurements of magnesium, over the next few years may assist in efficient treatment of disorders brought about by imbalances of magnesium.

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