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Editorial

Magnesium and Health

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EDITORIAL

Magnesium (Mg) is the second most abundant cation after potassium in the intracellular compartment and has a critical role in modulating a large variety of cellular activities and metabolic pathways. Mg is cofactor in over 300 enzymatic reactions including all reactions that involve ATP utilization and transfer [1,2]. Over the past decades, the clinical relevance of Mg and its impact on health has been documented. In the human body, around 24 grams (1 mole) of Mg are present. Less than 1% of total Mg is in the serum; normal serum Mg concentrations range between 0.75-0.95 mmol/L (1.7-2.5 mg/dL or 1.5-1.9 meq/L). In healthy adults, daily Mg requirement is around 300-400 mg (5 to 6 mg/kg/day) but it is higher in several physiological conditions (i.e. pregnancy, aging, exercise, etc.) and diseases (type-2 diabetes, infections, etc.). Severe Mg deficit may be associated with neuromuscular symptoms, such as weakness, tremor, muscle fasciculation, dysphagia, positive Chvostek's sign (facial twitching as a reaction to the tapping of the facial nerve), and positive Trousseau's sign (spasm of muscles of the hand and forearm following the application of a pressure cuff). Neurologic disturbances may involve the sympathetic and parasympathetic nervous systems, causing orthostatic hypotension or borderline hypertension. Mild to moderate Mg deficits are generally asymptomatic and clinical signs are usually absent and/or non-specific. Subjective symptomatology may include anxiety, hyperemotionality, and fatigue, depressive symptoms to major depression, headache, insomnia, light-headedness, and dizziness. Peripheral signs such as myalgias, paresthesias, and cramps may be present. Non-specific functional complains may include chest pain, sine materia dyspnea, precordialgia, palpitations, extrasystoles, etc. Hyperemotionality, tremor, asthenia, sleep disorders, amnesic and cognitive disturbances are particularly important in older adults, and may be often overlooked or confused with age-related symptoms [3].

Mg has a crucial role in several health conditions. Chronic Mg deficits have been linked to an increased risk of numerous clinical cardiovascular outcomes, mostly observed in older populations, including hypertension, ischemic heart disease, cardiac failure, cardiovascular mortality, stroke, cardiac arrhythmias, atherosclerosis, endothelial dysfunction, alterations in lipid metabolism, platelet aggregation/thrombosis, inflammation, oxidative stress [1,2]. Epidemiologic studies have suggested an inverse relationship between Mg intake and hypertension, lower dietary Mg intake being associated with higher blood pressure (BP). Therapeutical use of Mg is beneficial in preeclampsia and eclampsia and in patients with malignant hypertension, while the response to Mg in essential hypertensives is heterogeneous. In some studies, Mg supplementations have shown significant hypotensive effects, while in others BP did not change. Thus, even if a role for decreased Mg levels in the pathophysiology of hypertension appears likely, a consistent, reproducible effect of Mg supplementation on BP has not yet been confirmed and further data are needed to consider Mg as a non-pharmacological tool for reducing BP. Mg plays a role in the heart's electrical conduction as well. Mg deprivation has been suggested to compromise cardiovascular health and favor the occurrence of heart arrhythmias. Mg may be beneficial as a support in the treatment of arrhythmias, in particular when there is co-existent hypokalemia. Mg deficiency may also have a role in the development of atherosclerosis. Contrasting results have been reported on the relationship between serum lipids and Mg concentrations. Low Mg status has been suggested to contribute to vascular calcification, altered lipid accumulation, and reduced cholesterol transport by high density lipoprotein. Mg has been suggested to have a role in preventing atherosclerotic plaque formation, and to have a positive effect on lipid profiles as it may act as a weak inhibitor of 3-hydroxy-3-methylglutaryl-CoA-reductase activity.

The link between Mg deficiency and type 2 diabetes mellitus (DM2) is well known. DM2 is frequently associated with both extracellular and intracellular Mg depletion, in particular in patients with poorly controlled glycemic profiles, with longer duration of the disease, and with micro- and macrovascular complications [1-4]. Both a low Mg dietary intake and an increased Mg urinary loss may favor Mg depletion in diabetes. An inverse association between dietary Mg and the incidence of DM2 has been reported. A diet deficient in Mg is associated with insulin resistance and with an increased risk of developing glucose intolerance and DM2 [1]. The use of Mg supplements has been proposed as a potential tool for prevention and

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metabolic control of DM2. Benefits of Mg supplements on glycemic profile have been found in many, but not all, studies. Research concerning Mg supplementation in people with or at risk of diabetes is limited [1-4].

A possible role of Mg in the pathogenesis of bronchial constriction and in its treatment has been hypothesized [5], and several reports have showed positive results of Mg administration in airway constriction. Potential mechanisms for the direct relaxing effects of Mg on bronchial smooth muscle include calcium channel blocking properties, inhibition of cholinergic neuromuscular transmission, stabilization of mast cells, and stimulation of nitric oxide and prostacyclin. Data are in agreement for a role of a deficit in cellular and body Mg as a relevant contributor to an increased reactivity and contractility of smooth muscle in the vascular and bronchial tissues, causing both vasoconstriction and bronchoconstriction.

Mg deficits have been associated with numerous psychiatric disorders including depression, hypochondriasis, anxiety, behavioral alterations, panic attacks, hyperexcitability, cephalalgias, as well as focal seizures, ataxia, dizziness, tremor, irritability, insomnia, and psychotic behavior. Neuromuscular symptoms may include age-related muscular weakness, asthenia and myalgias (e.g., fibromyalgia and chronic fatigue syndrome). These conditions are generally, at least in part, reversible. Mg supplementation has been suggested to be useful for the treatment of depression but data are scarce. As a natural NMDA antagonist and a GABA agonist, Mg has also been used as an adjuvant in the treatment of insomnia.

Some epidemiological, experimental and clinical data have linked Mg depletion to dementia and Alzheimer's disease (AD) although the mechanisms of this association have not been clearly defined [6]. Mg concentration affects multiple biochemical mechanisms in the brain, which are involved in the cognitive process, including NMDA-receptor response to excitatory amino acids, cell membrane fluidity and stability, and toxic effects of calcium [6].

Mg deficiency has been proposed as a potential risk factor for developing osteoporosis and fragility fractures. Insufficient dietary Mg intake has been associated in humans with low bone mass and postmenopausal osteoporosis [3].

Mg status is crucial to muscle ATP concentration, muscle energetic metabolism and muscle contraction and relaxation, while Mg deficiency is associated with poor physical performance [7]. Muscle pain, weakness and night cramps may be associated with Mg deficiency. Mg deficiency may also contribute to the development of fibromyalgia. There are limited data about the effects of Mg treatment on fibromyalgia symptoms, although it has been suggested that Mg supplementation may have a role in reducing pain, tenderness, and symptom severity.

In conclusions, preserving an optimal Mg homeostasis throughout life might help to prevent some health conditions, associated with aging [7]. The possibility that Mg may supplementation may become a safe and economic health strategy is a suggestive hypothesis that needs to be proven by future prospective studies.

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