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REVIEW ARTICLE

Magnesium and its neglected importance for human health: a review study

Magnesio y su importancia desatendida para la salud humana: un estudio de revisión

Magnésio e sua importância negligenciada para a saúde humana: um estudo revisional

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Abstract

The aim was to evaluate the importance of magnesium in the physiological processes of the human body and list the consequences of its deficiency. This is a literature review study, as it contributes to the process of systematization and analysis of results, aiming to understand a certain topic, based on other independent studies. It was demonstrated that in adults, magnesium improved mood, anxiety, and quality of life and, there was a significant improvement in baseline depression and anxiety scores. These clinical data support magnesium as a treatment to improve stress-related mental health in individuals with suboptimal magnesium. Several studies have discussed the neuroprotective effect of magnesium in different types of paresthesia and neurodegenerative diseases such as stroke, Alzheimer's disease, migraines, Parkinson's disease, and even psychiatric diseases such as ADHD in children. In short, magnesium must be considered as a real metabolite since its deficiency has a great impact on different physiological functions.

Descriptors: Magnesium; Magnesium Supplement; Magnesium Deficiency; Magnesium and Metabolism; Endocrinology.

Resumén

El objetivo fue evaluar la importancia del magnesio en los procesos fisiológicos del cuerpo humano y enumerar las consecuencias de su deficiencia. Se trata de un estudio de revisión de la literatura, ya que contribuye al proceso de sistematización y análisis de resultados, con el objetivo de comprender un determinado tema, con base en otros estudios independientes. Se demostró que en los adultos, el magnesio mejoraba el estado de ánimo, la ansiedad y la calidad de vida y, además, hubo una mejora significativa en las puntuaciones iniciales de depresión y ansiedad. Estos datos clínicos respaldan el magnesio como tratamiento para mejorar la salud mental relacionada con el estrés en personas con niveles subóptimos de magnesio. Varios estudios han discutido el efecto neuroprotector del magnesio en diferentes tipos de parestesias y enfermedades neurodegenerativas como el ictus, la enfermedad de Alzheimer, las migrañas, la enfermedad de Parkinson e incluso en enfermedades psiquiátricas como el TDAH en niños. En definitiva, el magnesio hay que considerarlo como un auténtico metabolito, ya que su deficiencia tiene un gran impacto en diferentes funciones fisiológicas.

Descriptores: Magnesio; Suplemento de Magnesio; Deficiencia de Magnesio; Magnesio y Metabolismo; Endocrinología.

Resumo

Objetivou-se avaliar a importância do magnésio nos processos fisiológicos do corpo humano e listar as consequências de sua deficiência. Trata-se de um estudo de revisão da literatura, uma vez que ela contribui para o processo de sistematização e análise dos resultados, visando a compreensão de determinado tema, a partir de outros estudos independentes. Foi demonstrado que em adultos, o magnésio melhorou o humor, a ansiedade, a qualidade de vida e ainda, obteve-se significativa melhora dos escores basais de depressão e ansiedade. Esses dados clínicos apoiam o magnésio como um tratamento para melhorar a saúde mental relacionada ao estresse em indivíduos com magnésio abaixo do ideal. Diversos estudos têm discutido o efeito neuroprotetor do magnésio em diversos tipos de parestesias e doenças neurodegenerativas como o AVC, Doença de Alzheimer, enxaqueca, doença de Parkinson e ainda em doenças psiquiátricas como o TDAH em crianças. Em suma, o magnésio deve ser considerado como um metabólito real, visto que sua deficiência tem um grande impacto em diferentes funções fisiológicas.

Descritores: Magnésio; Suplemento de Magnésio; Deficiência de Magnésio; Magnésio e Metabolismo; Endocrinologia.

Introduction

Magnesium (Mg2+) is the 4th most abundant essential mineral in the human body, behind only calcium, potassium, and sodium. It is involved in several metabolic and biochemical processes and acts as a cofactor in hundreds of enzymatic reactions. It is a very important macromineral in the diet with a multitude of functions in the human body, including serving as a cofactor in more than 300 enzymatic reactions. Magnesium is essential for the regulation of muscle contraction, including that of the heart, blood pressure, and insulin metabolism, and is necessary for the synthesis of DNA, RNA, and proteins. In the nervous system, magnesium is important for optimal nerve transmission and neuromuscular coordination, as well as serving to protect against excitotoxicity (excessive excitement that leads to cell death)[1].

Analogous to calcium, the amount of body magnesium is regulated through three main mechanisms: intestinal absorption, renal reabsorption and excretion, and absorption from magnesium reservoirs. It is estimated that an adult human body contains around 21 to 28g of magnesium, approximately 50% of which is stored in the bones, and the remainder distributed in soft tissues, such as muscles[1].

Magnesium is also an essential component of extracellular fluid (ECF) and cerebrospinal fluid (CSF) in the central nervous system. It enters the brain through the blood-brain barrier, which maintains the passage of nutrients and electrolytes for ECF homeostasis and is actively transported by choroidal epithelial cells into the CSF. Although little has been revealed about the exact mechanisms of magnesium transport to the brain, it is known that the concentration of magnesium is higher in CSF than in plasma. Experimental studies have shown that in magnesium-deficient animals, brain absorption of magnesium is almost double compared to normally fed controls, showing that magnesium is an essential mineral for brain homeostasis[2].

Low levels of Mg2+ have been documented in patients since the end of the last century, however, despite its recognized importance, magnesium is often not monitored in patients and has been called the “forgotten cation”. Furthermore, serum magnesium levels generally do not reflect the magnesium content in different regions of the body. Therefore, a normal serum magnesium level does not exclude magnesium deficiency. Over the past 20 to 30 years, a large number of epidemiological, clinical, and experimental research studies have shown that abnormalities in magnesium levels, such as hypomagnesemia and/or chronic magnesium deficiency, can result in disorders in almost every body, contributing to or exacerbating pathological consequences and causing potentially fatal complications[2].

Many factors can affect magnesium deficiency, such as insufficient intake of this mineral; a diet rich in sodium, calcium, and protein; the consumption of caffeine and alcohol; the use of certain medications such as diuretics, proton pump inhibitors (such as omeprazole) and some antibiotics (which can cause less magnesium retention in the kidneys); chronic stress, low quality and quantity of sleep and a sedentary lifestyle. In healthy people, physiological conditions can lead to magnesium deficiency, such as pregnancy, menopause, or aging. Pathological conditions, especially those that affect nutrient absorption and elimination (diabetes, impaired kidney function, and physiological stress), can also result in significant loss of magnesium. Studies on hereditary forms of magnesium deficiency have contributed to the identification of recessive and dominant genetic diseases that directly affect magnesium transport at the cellular level[1,3].

Although it is a mineral contained in easily accessible foods, it is possible to affirm the inadequacy of the intake of several nutrients among individuals, including magnesium, as one of the minerals with reduced consumption by the population. Magnesium is a mineral found in several foods, but in varying concentrations, as it is a component of the chlorophyll structure, the main sources of which are dark green vegetables, whole grains, dried fruits, oilseeds, and tubers such as potatoes. Among other foods that are sources of magnesium, according to the values expressed in the food composition table (TACO) revision 04, we can point out grapes, bananas, avocados, grains, and their derivatives (granola, wheat germ, sunflower), chestnuts, walnuts, milk, soy, chickpeas, bread, fish, and other foods. The nutritional recommendations established and used as a reference for dietary guidance are the DRI (Dietary Reference Intakes) which for magnesium is 400 to 420 and 310 to 320 mg daily for adult men and women, respectively. The reference values of ANVISA's RDC No. 269 are presented under the recommended daily intake of magnesium is 260 mg for women and men. For the values used as recommendations, whether national, RDC, or international, RDI, there are questions about their functionality and the need for further studies, as there are few studies for this quantitative determination[3-6].

Magnesium deficiency can result from inadequate intake or increased excretion, with the homeostasis of this nutrient in our body regulated mainly by the kidneys, which triggers serious consequences for our body, including increased lipid peroxidation, to reduce antioxidant activity[3].

The objective of the present study is to evaluate the importance of magnesium in the physiological processes of the human body and list the consequences of its deficiency.

Methodology

This is a bibliographical review, as it contributes to the process of systematizing and analyzing results, aiming to understand a certain topic, based on other independent studies. In this work, the focus of the study was the mineral magnesium, a micronutrient from a food source that plays an important role in metabolic processes and human health.

The following inclusion criteria were adopted: studies with full texts available for analysis and that are electronically indexed on the PubMed and SciELO websites. The articles were searched in Portuguese, English, and Spanish. The keywords used for the search addressed the variables studied, such as: “Benefits of Magnesium”, “Food Sources of Magnesium”, “Magnesium Lack”, “Ways to Supplement Magnesium”, “Action of Magnesium on

Metabolism", "Magnesium Deficiency" and "Benefits of Magnesium for the Human Body". The terms used for the search were: "Magnesium", "Magnesium Supplement", "Magnesium Deficiency", "Magnesium and Metabolism", and "Magnesium and Human Health".

The exclusion criteria adopted in this study were: articles not freely available; articles available only in abstract; and publications such as letters, comments, and editorials. From the material obtained, each summary/article was read in detail, carrying out a qualitative analysis on the topic, highlighting those that responded to the objective proposed by this study, to organize and tabulate the data. Following the inclusion criteria, seven studies were selected, which are referenced in this text.

The search and selection stages of articles for reading the full text and eligibility for qualitative analysis were carried out by the authors from March to June 2022. The inclusion and selection period was from 2019 to 2022.

Results and Discussion

In the analysis carried out[7], it was demonstrated that in adults, magnesium improved mood, anxiety, and quality of life, and there was a significant improvement in baseline depression and anxiety scores on the DASS-42 scale to normal or close to normal levels in the 8th week of use, with the greatest change observed during the first 4 weeks. These clinical data support magnesium as a treatment to improve stress-related mental health in individuals with suboptimal magnesium.

Several studies have discussed the neuroprotective effect of magnesium. In vitro studies in mice confirmed its relationship with NMDA receptors and the inhibition of glutamate release. Neuroscience has associated neurological disorders with Mg2+. Damage to peripheral nerves results in various types of paresthesia and neurodegenerative diseases (such as stroke), Alzheimer's disease (AD), migraines, and Parkinson's disease). The neuroprotective role of Mg2+ has been proven, but its role in pathogenesis remains ambiguous. The use of a carrier, such as polyethylene glycol, can solve this problem, reducing the dose of central effects and deleterious peripheral effects[8].

Researchers[9] evaluated the consequences of magnesium supplementation in children with attention deficit hyperactivity disorder (ADHD). Many previous observational studies have shown that serum magnesium levels in children with ADHD was lower than control levels. There is an association between serum levels of magnesium and vitamin D. Vitamin D supplementation can improve serum magnesium levels, similarly, magnesium intake may be associated with reduced risks of vitamin D deficiency and insufficiency and magnesium can affect vitamin D production. Additionally, vitamin D and magnesium affect similar areas of the brain involved in behavior. In conclusion of the study, they observed that vitamin D and magnesium supplementation in children with ADHD was effective in reducing conduct problems, social problems and reducing levels of anxiety and shyness compared to placebo intake but did not significantly reduce psychosomatic problems.

Conclusion

Magnesium should be considered as an actual metabolite rather than a simple electrolyte, as its deficiency has a major impact on different physiological functions. Many studies indicate that in most adults, dietary magnesium intake is insufficient, and that subclinical magnesium deficiency is a widespread condition in the Western population. Therefore, more attention should be paid to the preventive role of magnesium for pathologies, encouraging a more adequate dietary intake of the mineral and supplementation, since magnesium deficiency occurs even when serum levels are within the recommended range. Therefore, the specificity of the tests needs to be improved. Magnesium is found in a wide variety of foods and can also be obtained via supplementation. Additionally, studies have shown that magnesium supplements are well tolerated and generally improve several markers of disease status.

Magnesium, despite having widespread importance in human health, affects several metabolic and neural processes, for example, its benefits are still little explored, which is the biggest limitation of the present study. Further studies are needed to establish more effectively and cohesively what the recommended values for daily human consumption are, since existing standards are discrepant and based on unique or insufficient data and the relationships between quantity consumed, via food or supplementation, and benefits.

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