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There is chronic latent magnesium deficiency in apparently healthy university students

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Abstract

Introduction: **Magnesium is an essential micronutrient for human body, and its deficiency has been associated with risk of non-communicable diseases.**

Objective: **Assessment of magnesium status, and evaluation of the frequency of magnesium deficiency in a group of healthy adults.**

Methods: **Plasma and erythrocyte magnesium levels, and magnesium intake were determined in 115 students (55 women and 60 men), from a public university in Brazil.**

Results: **The medians of magnesium concentration in plasma (0.76 mmol/L), erythrocyte (1.97 mmol/L), and of dietary daily intake (8.84 mmol/d) were low. Forty two percent of participants had plasma or erythrocyte magnesium below the limit of 0.75 and 1.65 mmol/L, respectively. A high percentage showed high probability of inadequate magnesium intake.**

Conclusions: **There was a high frequency of subclinical magnesium deficiency in the adults assessed, that could be related to low dietary magnesium intake.**

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Key words: *Magnesium deficiency. Nutritional status. Adult. Students.*

HAY DEFICIENCIA CRONICA LATENTE DE MAGNESIO EN ESTUDIANTES UNIVERSITARIOS APARENTEMENTE SANOS

Resumen

Introducción: **El magnesio es esencial, y su deficiencia ha sido asociada a mayor riesgo de enfermedades crónicas.**

Objetivos: **Evaluar el estado de nutrición de magnesio y su ingesta en adultos sanos, y determinar la frecuencia de su deficiencia en esta población.**

Métodos: **Fueron evaluados 115 adultos estudiantes de una universidad pública en Brasil, y se determinó la ingesta dietética y los niveles de magnesio en plasma y eritrocitos.**

Resultados: **Las medianas de distribución de magnesio en plasma (0,76 mmol/L), en eritrocitos (1,97 mmol/L), y la ingesta de magnesio (8,84 mmol/d) fueron bajas. Un 42% de la muestra tuvieron concentración de magnesio en plasma o eritrocitos por debajo de los respectivos 0,75 mmol/L y 1,65 mmol/L. Un alto porcentaje de ellos exhibió probabilidad de ingesta de magnesio inadecuada.**

Conclusiones: **Se observó una alta frecuencia de deficiencia de magnesio subclínica en los adultos evaluados.**

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Palabras clave: *Deficiencia de magnesio. Estado nutricional. Adulto. Estudiantes.*

Abreviations

BMI: Body mass index.
DRI: Dietary reference intake
EAR: Estimated average requirement.
NCD: Non-communicable diseases.
UFRN: Federal University of Rio Grande do Norte.

Introduction

The role of magnesium in the incidence and progression of non-communicable diseases – NCD (type 2 diabetes, hypertension, cardiovascular diseases, metabolic syndrome, and osteoporosis) have been demonstrated elsewhere[1,2].

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Although it is found in a wide variety of foods, according to current magnesium estimated average requirement (EAR, 255-265 mg/d for female and 330-350 mg/d for male adults)[1] the population of many countries may be vulnerable to chronic latent magnesium deficiency, with severe long-term consequences to their health[2,3].

According to recent Brazilian Food Survey, the prevalence of inadequacy of magnesium intake was over 70%, especially in urban areas. In Brazil, the nutritional habits and food availability vary widely among the different regions and the different income patterns of the population. However, it may be assumed that it is based on beans, polished rice, meat and meat products and less in magnesium food sources as fruits, vegetables, nuts and dairy products[4].

The aim of this study was to assess the intake and status of magnesium in apparently healthy university students from a public university in the Northeast city of Natal.

Methods

This study was approved by the Ethics Committee on Research of the Federal University of Rio Grande do Norte – UFRN (protocol # 154/03).

Subjects

A cross-sectional study was carried out in a random sample (n = 115) of apparently healthy adult students from UFRN, of both genders. The sample size was calculated considering the total of undergraduate students from this university (n = 19,847), using an expected frequency of magnesium deficiency of 9%, the highest prevalence of hypomagnesemia published in literature since 2003[5], with an error of 5%, and confidence interval of 90%.

The participants were randomly selected according to the following inclusion criteria:

1. Being a student at the UFRN.
2. Aged from 19 to 30 years; not being malnourished or obese, pregnant or lactating.
3. Not suffering from chronic or acute disease.
4. Non athlete.
5. No current history of smoking, alcoholism, drug abuse or use of vitamin-mineral supplement or medication (including contraceptives).

Study design

Participants initially completed a standard questionnaire with general information. Those who were selected according to the inclusion criteria came to the laboratory after a 12-14 h fasting, when blood samples were collected and their weight, height and dietary intake were assessed.

Anthropometric measurement

Body weight was measured using calibrated digital scales (0.1 kg precision – Plenna, São Paulo, SP, Brazil) with participants wearing light clothes and no shoes. Height was obtained (0.1 mm precision) using a square and an inextensible tape, fixed on wall with no baseboard. Body mass index (BMI) was calculated, and the participants categorized according to World Health Organization classification: < 18.5 kg/m^2 underweight, 18.5 to 24.9 kg/m^2 normal weight, 25.0 to 29.9 kg/m^2 pre-obesity, > 30.0 obesity[6]. These measurements were obtained by a trained team of nutritionists and nutrition students.

Magnesium intake

One 24-h food recall was applied by trained nutritionists. The magnesium intake was estimated with the use of the *VirtualNutri* software[7]. The prevalence of inadequacy was evaluated from: z = (EAR – mean intake of the group)/standard deviation of group[8].

Magnesium status

All glassware was demineralized prior to analyses. Plasma and erythrocyte magnesium concentrations were determined by flame atomic absorption spectrometry (AAnalyst 100; Perkin Elmer, Norwalk, CT, USA), according to previously standardized and validated protocols[9].

The method's detection limits were 0.0006 mg/dL (0.0002 mmol/L) for plasma, and 0.0003 mg/dL (0.0001 mmol/L) for erythrocytes. Precisions of 95-96% were obtained for plasma and erythrocyte analyses. The precisions were verified using secondary standards (samples of plasma and erythrocyte pools) prepared in our laboratory. The magnesium concentration reference ranges were: plasma 0.75-0.96 mmol/L,[3] and erythrocytes 1.65-2.65 mmol/L[10].

Statistical analyses

Statistical analyses were performed using SPSS software (Chicago, IL, USA) version 15.0. All data were normally distributed (Kolmogorov-Smirnov test), so the means were compared by Student t-test for independent samples. The level of significance α established was 5%.

The residual method of adjustment of magnesium intake was used to minimize the effect of energy in dietary calculations[11].

Results

The participants, aged 19 to 29 years, reported high percentage of family history of non-communicable disease (81.7%) and physical inactivity (69.8%). Men (52% of the sample) had BMI higher than women (table I).

Men and women had similar magnesium intake and status, evaluated by plasma and erythrocyte magnesium (table I). The probability of inadequate magnesium intake was 70% among women and 94% among men (figs. 1A and B).

Mean plasma and erythrocyte magnesium concentrations were close to the lower cut-off point (table 1). A considerably percentage of the participants had plasma (34%) and erythrocyte magnesium (17%) below the lower reference range (figs. 1C to 1F), and 8% had both: reduction in plasma and erythrocyte magnesium.

Discussion

Assessment of food intake followed by the adequate choice and interpretation of biochemical parameters are the main tools for the evaluation of micronutrient related nutritional status.

The frequency of inadequate magnesium intake in the population of this study was high, especially in men, where the values exceeded 90%. The 70% inadequacy found in women was similar to that shown in the 2008-2009 National Food Survey, in the same region[4]. On the other hand, a considerable percentage of both men and women had plasma but no erythrocyte magnesium below the lower limit of the reference.

The average low magnesium intake of 8.84 mmol/d observed was lower than that of healthy population of other countries[5,12,13], and is most probably due to the low consumption of magnesium food sources (whole grains, dark green vegetables, nuts). The foods that most contributed to magnesium intake were fruits (papaya, guava, orange, banana, and tomato), beans; corn couscous; coffee; milk; and chocolate powder, and are considered moderate to poor magnesium sources.

Hypomagnesemia was present in a 34% frequency, which was higher than that found in other populations of apparently healthy adults (5% in North of Mexico[12], 9% in Southern Spain)[5]. Besides, if the cutoff point of 0.85 mmol /L for plasma magnesium, recommended by Elin,[3] is used, this value would increase to 87%.

According to this author[3], due to the great inclusion of processed foods in the habitual diet in the past century, there was a reduction in magnesium intake. Thus, those individuals who have inadequate magnesium ingestion and concomitantly plasma/serum magnesium concentration between 0.75 and 0.85 mmol/L, in fact, should be classified as chronic latent magnesium deficient (or subclinical magnesium deficient). The interchangeable plasma magnesium pool has its concentrations tightly regulated through kidney excretion, and bone resorption. So, in order to maintain

Table I
Characteristics and magnesium status of the population under study, by gender

Parameters	*Unit*	*Total (n = 115)*	*Gender*		*p**
			Female (n = 55)	*Male (n = 60)*	
age	(y)	22.5 ± 2.5 (22.1)	22.3 ± 2.4 (22.0)	22.1 ± 2.4 (22.0)	0.703
BMI †	(kg/m²)	22.5 ± 2.6 (22.1)	21.5 ± 2.3 (20.9)	23.3 ± 2.5 (23.1)	< 0.001
normal weight	(%)	84.3	90.9	78.3	–
pre-obesity	(%)	15.7	9.1	21.7	–
dietary magnesium‡	(mmol/d)	8.84 ± 3.07 (8.44)	8.71 ± 3.20 (8.38)	8.95 ± 2.98 (8.71)	0.673
	(mg/d)	214.8 ± 74.7 (211.2)	211.7 ± 77.7 (203.7)	217.6 ± 72.4 (211.6)	0.673
plasma magnesium§	(mmol/L)	0.76 ± 0.06 (0.76)	0.76 ± 0.06 (0.76)	0.77 ± 0.07 (0.77)	0.213
	(mg/dL)	1.86 ± 0.16 (1.85)	1.84 ± 0.14 (1.84)	1.88 ± 0.17 (1.88)	0.213
erythrocyte magnesium§	(mmol/L)	1.97 ± 0.33 (1.94)	1.98 ± 0.33 (1.93)	1.96 ± 0.32 (1.96)	0.844
	(mg/dL)	4.79 ± 0.79 (4.72)	4.80 ± 0.81 (4.70)	4.78 ± 0.79 (4.76)	0.844
	(mmol/g Hb)	8.15 ± 2.01 (7.95)	8.27 ± 2.09 (7.97)	8.05 ± 1.95 (7.92)	0.553
	(mg/g Hb)	198.2 ± 48.8 (193.3)	201.2 ± 50.7 (193.8)	195.6 ± 47.5 (192.6)	0.553

The results are expressed as mean ± standard deviation with the median value shown in parenthesis or%
* The means were compared by Student t-test for independent samples
† BMI classifications: normal weight, 18.5-24.9 kg/m²; pre-obesity, 25.0-29.9 kg/m²
‡ Data adjusted according to the individual energy intake. The estimated average requirements for an individual aged 19-30 years are: 10.5 mmol/d (255 mg/d) for women, 13.6 mmol/d (330 mg/d) for men.
§ Normal magnesium range: 0.75-0.96 mmol/L (1.82-2.33 mg/dL)[3] for plasma; 1.65-2.65 mmol/L (4.01-6.44 mg/dL)[10] for erythrocyte.

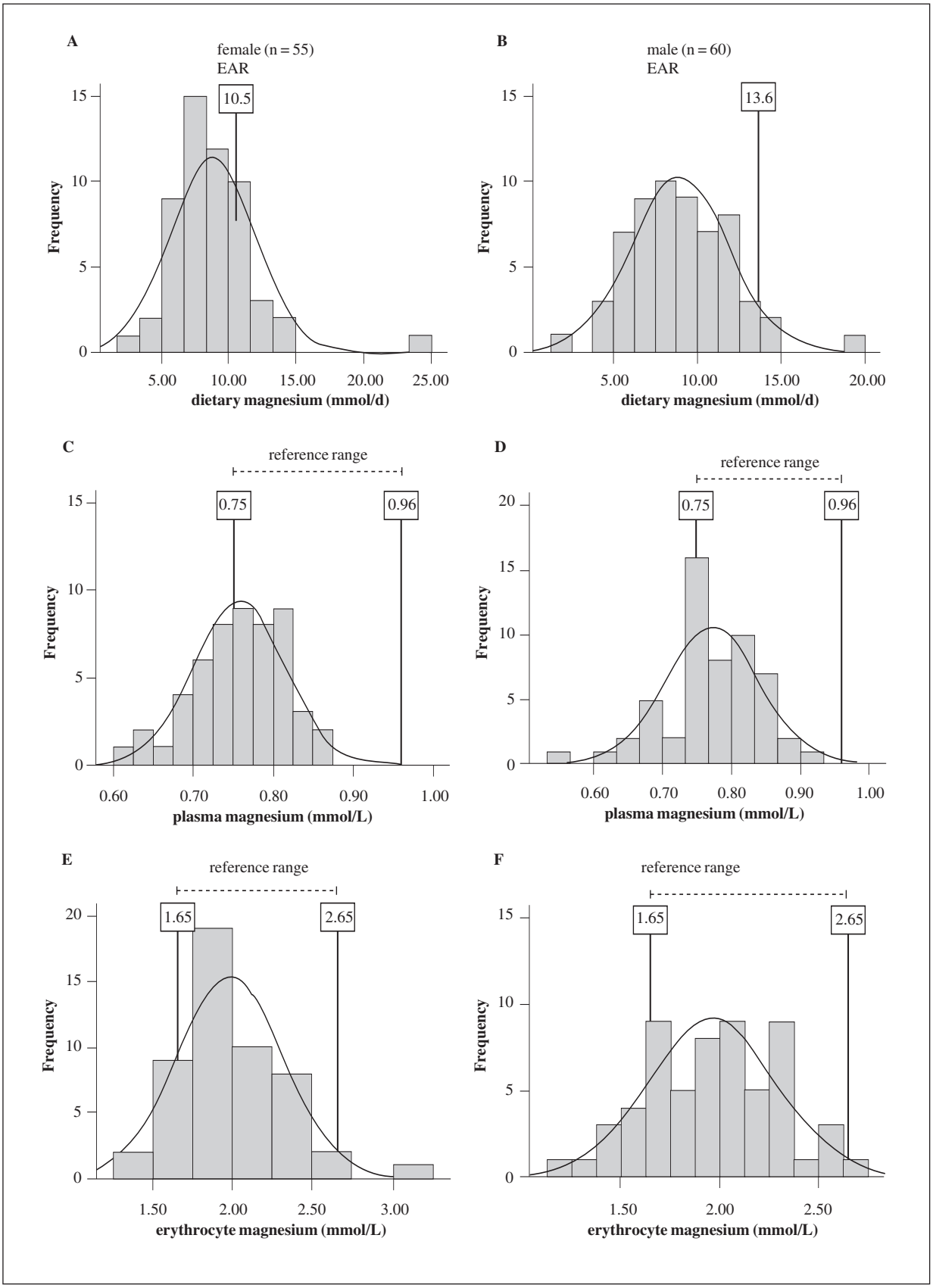

Fig. 1.—Distribution of magnesium intake, plasma and erythrocyte magnesium from participants, by gender (EAR: estimated average requirement).

plasma magnesium within the reference interval, these individuals certainly have depleted reserve (bone) compartments[3,14].

Although the plasma magnesium pool represents less than 1% of total body magnesium[14], its assessment cannot be disregarded when magnesium status is evaluated. Long-term dietary magnesium restriction could result in magnesium decompartmentalization, before clinical signs and symptoms of magnesium deficiency become evident[2,3]. Nevertheless, the detection of magnesium deficiency only by clinical signs and symptoms is difficult because they are pathognomonic for many diseases[1,14].

Although it is not completely clear how low magnesium intake predisposes to NCD[1], the magnesium deficiency observed in the present study in apparently healthy adults is worrying, due to the high frequency of family history of NCD reported by the participants, which is significant in the local population, as demonstrated in a telephone survey conducted by the Brazilian Health Ministry. In this survey, the findings showed a prevalence of 5.8% for diabetes, 24.9% for hypertension, and 18.5% for obesity[15].

In conclusion, the high frequency of subclinical magnesium deficiency in the adults assessed in this study can be attributed to their low dietary magnesium intake. Although the association of magnesium deficiency with the development of NCD is not completely understood, it is reasonable to address the focus of future research to the evaluation of magnesium status in a larger and significant sample of the Brazilian population.

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Conflict of Interest Declaration

The authors have no potential conflicts of interest that could inappropriately influence this work.

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