



Original / *Valoración nutricional*

Association between magnesium-deficient status and anthropometric and clinical-nutritional parameters in postmenopausal women

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Abstract

Background: During menopause occurs weight gain and bone loss occurs due to the hormone decline during this period and other factors such as nutrition. Magnesium deficiency suggests a risk factor for obesity and osteoporosis.

Objective: To evaluate the clinical and nutritional magnesium status in a population of postmenopausal women, assessing intake and serum levels of magnesium in the study population and correlation with anthropometric parameters such as body mass index (BMI) and body fat, and biochemical parameters associated.

Subjects and Method: The study involved 78 healthy women aged 44-76, with postmenopausal status, from the province of Grenade, Spain. The sample was divided into two age groups: group 1, aged < 58, and group 2 aged ≥ 58. Anthropometric parameters were recorded and nutritional intake was assessed by 72-hour recall, getting the RDAs through Nutriber[®] program. To assess the biochemical parameters was performed a blood sample was taken. Magnesium was analyzed by flame atomic absorption spectrophotometry (FAAS) in erythrocyte and plasma wet-mineralized samples.

Results: Our results show that 37.85% of the total subjects have an overweight status. Magnesium intake found in our population is insufficient in 36% of women, while plasma magnesium deficiency corresponds to 23% of the population and 72% of women have deficient levels of magnesium in erythrocyte. Positive correlations were found between magnesium intake and dietary intake of calcium, of phosphorus, and with prealbumin plasma levels, as well as with a lower waist / hip ratio. Magnesium levels in erythrocyte were correlated with lower triglycerides and urea values.

Conclusion: It is important to control and monitor the nutritional status of magnesium in postmenopausal

ASOCIACIÓN DE LA DEFICIENCIA DE MAGNESIO CON PARÁMETROS ANTROPOMÉTRICOS Y CLÍNICO-NUTRICIONALES EN MUJERES POSMENOPÁUSICAS

Resumen

Introducción: Durante la menopausia se produce un aumento de peso y de pérdida de masa ósea debido a la disminución hormonal producida durante este periodo y a otros factores como la nutrición. La deficiencia de magnesio podría ser un factor de riesgo para la obesidad y la osteoporosis.

Objetivo: Evaluar el estado clínico-nutricional en una población de mujeres postmenopáusicas, evaluando la ingesta y los niveles séricos de magnesio, y su correlación con parámetros antropométricos, como el índice de masa corporal (IMC) y la grasa corporal, así como con parámetros bioquímicos asociados.

Sujetos y Metodología: En el estudio participaron 78 mujeres sanas en situación de postmenopausia de la provincia a de Granada, con edades comprendidas entre los 44-76 años. La muestra se dividió en dos grupos de edad: grupo 1, mujeres postmenopáusicas con edad menor de 58 años y grupo 2, de edad mayor o igual a 58 años. Se registraron parámetros antropométricos y se valoró la ingesta nutricional mediante recordatorio de 72 horas, obteniendo las RDAs a través del programa Nutriber[®]. Para valorar los parámetros bioquímicos se realizó una extracción de sangre y el magnesio se analizó mediante espectrofotometría de absorción atómica de llama (FAAS) en muestras de eritrocitos y plasma previamente mineralizadas por vía húmeda.

Resultados: Nuestros resultados muestran que el 37.8% de las mujeres presentan sobrepeso. La ingesta de magnesio encontrada en nuestra población es insuficiente en el 36% de las mujeres, mientras que la deficiencia de magnesio plasmático y eritrocitario corresponde al 23% y el 72% de las mujeres, respectivamente. Se observaron correlaciones significativas positivas entre el aporte de magnesio en la dieta y el aporte de calcio, de fósforo, y los niveles plasmáticos de prealbúmina, además de con una menor relación cintura/cadera. Los niveles de magnesio en eritrocito se correlacionaron con los niveles de triglicéridos y con menores valores de urea.

Conclusión: Es importante un control y seguimiento de la situación nutricional en magnesio d la mujer postme-

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women to prevent nutritional alterations and possible clinical and chronic degenerative diseases associated with magnesium deficiency and with menopause.

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nopáusica para prevenir alteraciones clínico-nutricionales y posibles enfermedades crónico-degenerativas relacionadas con la deficiencia del magnesio y la menopausia.

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Introduction

Menopause is a natural status of the woman and is determined by the cessation ovarian hormone secretion, leading to the disappearance of menstrual cycles and the emergence of a set of physiological changes causing among others, bone loss, increased abdominal adiposity, insulin resistance, hypertension and dyslipidemia, factors that increase the risk of chronic degenerative diseases such as cardiovascular disease, diabetes and osteoporosis^{1,2}. It appears at an age that, in Spain, is around age of 51, with a spectrum ranging from 48 to 54³.

In this situation women menopause presents a greater risk of obesity, by increasing fat percentage and fat distribution with higher accumulation in the abdominal area, while lean body mass decreases and bone tissue^{4,5}.

One of the main causes of this weight gain is related to decreased hormone produced during this period and others depend on several factors such as age, lack of physical activity and increased caloric intake, resulting in a decrease in energy expenditure. Moreover, at this stage, occurs accelerated bone loss can cause osteoporosis⁶ and significant increase in fracture risk, being an important factor in the pathogenesis both estrogen and nutrition lack. Nutritional factors have multiple effects by acting on the peak bone mass, bone loss related to age and strength muscular⁴. Therefore, we cannot forget the importance of maintaining healthy eating habits for achieving the goal of bone health.

Magnesium is involved as an essential cofactor in numerous enzymatic reactions involved in energy metabolism and the synthesis of proteins and nucleic acid, and about half of a body contained in the bone is therefore not surprising that an increasing number of clinical disorders such as diabetes, osteoporosis and vascular diseases, are associated with deficiency Himself^{7,8}. Postmenopausal women are often associated with a low dietary intake of magnesium and decreased serum levels thereof in numerous studies showing that magnesium deficiency suggests a risk factor for obesity and osteoporosis⁸⁻¹⁰.

Therefore, a healthy and balanced is essential at this stage and help ensure optimal health. Menopause can be a consolidation phase eating habits practiced correctly that help prevent and mitigate some problems as described above, achieving healthy aging.

In addition to conducting a proper and healthy diet is necessary to maintain or incorporate into daily life a number of lifestyles also considered healthy example would be the daily practice of physical exercise and avoiding harmful habits that affect bone health as snuff, and alcohol consumption^{11,12}.

The aim of this study is to evaluate the clinical and nutritional status in a population of postmenopausal women, assessing magnesium status in the study population, by ingestion and analysis of biological samples, and finally, to study possible associations with anthropometric parameters such as BMI and body fat, and clinical parameters-related nutritional magnesium metabolism.

Subjects and methods

Study Design

A cross-sectional study, which measures both the prevalence of exposure and effect in a population sample in a single moment in time. The study has approval from the Ethics Committee of the University of Granada.

Study Subjects

The sample consisted of 78 female volunteers in the province of Granada, Spain, in postmenopausal status aged between 44 and 76. The sample was divided into two age groups: group 1, postmenopausal women aged fewer than 58 and group 2 aged greater than or equal to 58. All received detailed information about the purpose of the study, accompanied by informed consent form to be signed prior to recording his acceptance to be part of it. Inclusion criteria were based on the agreement to participate in the study, by postmenopausal women of any age, which do not have any pathology that could affect their nutritional status and were not undergoing hormone replacement therapy.

Methods

Subjects underwent an interview nutritional and fasting blood extraction for subsequent biochemical

tests. Interview Nutritional Data collection to assess food and nutrient intake of each of the participating women was conducted by personal interview at the time of the appointment. A questionnaire consisting of a section for personal information and one for socio-demographic, age, weight and height (with which was calculated the body mass index-BMI-), and finally, a 72h-recall (where includes two days and one holiday). The anthropometric evaluation was performed at the Institute of Nutrition and Food Technology, University of Granada, by measures of size, made with measuring rod SECA® Model 274, waist circumference determined anthropometric tape SECA® Model 201, and body composition performed with impedance meter TANITA® BC-420-P column. To assess the extent of nutrient intake was used *Nutriber*® software program (Mataix and Garcia-Díz, 2006), containing the recommendations for healthy population.

Removing blood

Blood sampling for determination of relevant biochemical parameters were performed on women participating voluntarily, after the completion of the survey the day of the appointment.

Biochemistry was performed after 12 hours of fasting first thing in the morning, by specialists, by puncturing the cubital vena cava determining the parameters for postmenopausal women. Biochemical assessment was performed in hospital laboratories, based on the analysis parameters in blood samples by *vacutainer* tubes (Venoject®): glucose, creatinine, urea, uric acid, triglycerides, total cholesterol, total proteins, transferrin, prealbumin and albumin. For determining mineral, analytical techniques were as

follows: Calcium and magnesium were analyzed by atomic absorption spectrophotometry (AAS) in erythrocytes and plasma samples wet mineralized. The phosphorus was determined with the colorimetric method of Fiske-Subbarow.

Statistical Analysis

All data are entered, processed and analyzed using SPSS 17.0 for Windows (SPSS Inc. Chicago, IL, USA), represented by their mean values and standard deviation (SD).

In the study of data or numeric variables we used the independent samples test for comparisons between groups and test for related sample to assess the statistical significance of the change in the numerical variables during the study. For this, we used the statistical analysis of variance (ANOVA), having used the test of Student t test for parametric methods, both in the case of independent samples, and related samples. Linear regression analysis was used for bivariate correlations search using the Pearson correlation coefficient. The estimation of the degree of association between each of the analyzed plasma parameters and clinical outcomes was performed using logistic regression analysis. Those were accepted as significant difference with a probability of being due to chance of less than 5% ($p < 0.05$).

Results

Table I represents the age, BMI and nutrient intake in all postmenopausal women participating in the study and separated by age groups (Group 1: aged < 58 and group 2: aged ≥ 58).

Table I						
Evolution of general and nutritional characteristics of the total sample and in different age groups						
	Total population		Group 1		Group 2	
						Reference values
Age (years)	58.1 ± 8.3		51.6 ± 4.05		65.7 ± 4.8**	
BMI (kg/m ²)	27.0 ± 4.6		26.9 ± 4.8		27.1 ± 4.3	18.5-24.9
Abdominal perimeter (cm)	89.0 ± 12.7		88.0 ± 9.4		90.2 ± 13.1	a
Hip (cm)	105.8 ± 10.4		105.7 ± 9.5		105.8 ± 11.6	
Waist / hip ratio	0.83 ± 0.08		0.82 ± 0.08		0.85 ± 0.07	b
Fat Mass (%)	37.5 ± 5.9		37.4 ± 5.5		37.8 ± 6.4	
		% RDA		% RDA		% RDA
Energy (Kcal/day)	1378.5 ± 337.4	69.0	1357.2 ± 393.1	65.4	1404.1 ± 258.6	73.3
Carbohydrates (g/day)	149.7 ± 42.5	54.2	146.3 ± 47.2	50.8	153.6 ± 36.5	58.2
Protein (g/día)	61.5 ± 15.3	148.7	61.1 ± 16.9	146.3	62.1 ± 13.5	151.4
Lipids (g/día)	59.0 ± 20.6	82.4	58.2 ± 23.1	76.8	60.0 ± 17.7	88.9
Calcium (mg/day)	829.5 ± 257.2	103.7	802.3 ± 286.1	100.3	861.0 ± 218.6	107.6
Phosphorus (mg/day)	1038.8 ± 304.9	129.4	1037.3 ± 283.9	129.6	1040.5 ± 331.7	129.2
Magnesium (mg/day)	237.9 ± 79.8	78	219.8 ± 67.7	70.8	259.0 ± 88.3*	86.3

a>88 elevated risk of obesity; b > 0.85 obesity. Significant differences between group 1 and group 2: ** $p < 0.01$ * $p < 0.05$.

We note, by the comparison test of means in anthropometric parameters, no significant differences between the age groups, except between age ($p < 0.01$), being higher in the older group.

In our results, the mean BMI indicates that the total population is overweight type I, 37.85% of the total subjects are overweight, which is not surprising when you consider that from that age significantly decreases basal metabolism in women, and often not accompanied by a reduction in the intake caloric.

RDAs according to both the total population and in the different age groups, these values were below in total energy intake, carbohydrates, fats and magnesium above protein, calcium and phosphorus (table I).

When comparing age groups, regarding nutritional intake, no significant differences, both groups showed similar values, except for magnesium intake is higher in the older group ($p < 0.05$).

Moreover, we found that the total study sample, has a 36% of subjects with inadequate intake of magnesium ($< 2/3$ RDA).

Biochemical characteristics of the total sample and in the two age groups are shown in table II. Overall, our study population presented clinical parameters within normal, except cholesterol levels that are above the reference values, and whose difference is negligible in both groups. These are healthy women without apparent disease, since one of the inclusion criteria was that women had not established pathologies

When comparing age groups, significant differences ($p < 0.05$) in the levels of creatinine, urea, uric acid, prealbumin, albumin and glucose ($p < 0.01$), being higher in older women, with the exception of q albumin is higher in younger women.

Observed that magnesium values in both plasma and red blood cells are suitable, are within the reference values and there are almost no differences in body

magnesium status between age groups. The 23% of people are deficient in magnesium levels in plasma and 71.8% deficiency in magnesium levels in erythrocytes.

According to Pearson correlations, there were significant positive correlations between age and glucose levels ($p < 0.001$, $r = 0.421$), urea ($p = 0.009$, $r = 0.299$), uric acid ($p = 0.001$, $r = 0.378$), and total bilirubin ($p = 0.009$, $r = 0.298$).

Also between BMI with the lowest energy ($p = 0.040$, $r = -0.234$) and glucose levels ($p = 0.019$, $r = 0.266$) and uric acid ($p = 0.015$, $r = 0.277$).

As for magnesium related parameters, positive correlations were observed between the contribution of dietary magnesium and calcium intake ($p < 0.001$, $r = 0.498$), phosphorus ($p < 0.001$, $r = 0.580$) and plasma levels of prealbumin ($p = 0.035$, $r = -0.266$), along with a smaller waist / hip ratio ($p = 0.042$, $r = -0.235$).

Regarding magnesium levels in erythrocytes were obtained correlations between erythrocyte magnesium levels with triglycerides ($p = 0.011$, $r = 0.287$) and lower values of urea ($p = 0.017$, $r = -0.272$).

Discussion

The prevalence of overweight was found similar to that reported by other studies¹³⁻¹⁵, being similar in both age groups, however this situation has no relation to the average caloric intake of the diet study, which appears insufficient. This may be due, in addition to hormonal changes associated with menopause, which leads to increased weight, the age-related factors, since although the energy requirements decrease with age (about 5% per decade after age 40), women at this stage remains the same eating habits, to which we must add the low energy expenditure characteristic of this age^{9,20}.

Table II
Biochemical characteristics of the total sample and in different age group

Analyzed parameters	Total population Media \pm DS	Group 1 aged < 58 Media \pm DS	Group 2 aged \geq 58 Media \pm DS	Reference values
Glycemia (mg/dL)	92.1 \pm 15.9	87.4 \pm 12.3	97.4 \pm 17.8**	70-110 mg/dL
Creatinine (mg/dL)	0.69 \pm 0.13	0.67 \pm 0.08	0.70 \pm 0.16*	0.5-0.9 mg/dL
Urea (mg/dL)	34.5 \pm 9.08	32.2 \pm 8.02	37.2 \pm 9.6*	10-50 mg/dL
Uric acid (mg/dL)	4.4 \pm 1.07	4.1 \pm 0.8	4.7 \pm 1.2*	2.4-5.7 mg/dL
Triglycerides (mg/dL)	108.2 \pm 67.9	108.2 \pm 82.0	108.1 \pm 48.3	50-200 mg/dL
Cholesterol (mg/dL)	220.4 \pm 34.3	219.1 \pm 33.6	222.0 \pm 35.5	110-200 mg/dL
Transferrin (mg/dL)	280.2 \pm 45.8	278.9 \pm 43.1	281.8 \pm 50.0	200-360 mg/dL
Prealbumin	25.2 \pm 5.1	25.6 \pm 4.5	24.6 \pm 5.8*	20-40 mg/dL
Albumin (mg/dL)	4.4 \pm 0.2	4.5 \pm 0.2	4.4 \pm 0.1*	3.5-5.2 mg/dL
Total protein (g/dL)	7.1 \pm 0.5	7.1 \pm 0.5	7.0 \pm 0.5	6.6-8.7 mg/dL
Calcium (mg/dL)	9.2 \pm 0.4	9.1 \pm 0.4	9.2 \pm 0.5	8.6-10.2 mg/dL
Phosphorus (mg/dL)	3.5 \pm 0.5	3.4 \pm 0.5	3.6 \pm 0.4	2.7-4.5 mg/dL
Mg plasma (mg/dL)	1.8 \pm 0.2	1.8 \pm 0.2	1.8 \pm 0.2	1.7-2.6 mg/dL
Mg erythrocyte (mg/dL)	3.9 \pm 0.7	4.0 \pm 0.6	3.9 \pm 0.8	4.2-6.7 mg/dL

Significant differences between group 1 vs group 2: ** $p < 0.01$, * $p < 0.05$.

Regarding nutritional intake no significant differences, both groups showed similar values (fig. 1), except for magnesium intake is higher in the older group. Macronutrient intake in our population is similar to the results observed in other studies^{9,16}.

Consumption of total carbon hydrates is low, which would explain the results obtained energy intake, since women had intakes carbon hydrates significantly lower than recommended.

Fat intake is decreased but close to the recommendations, so it follows that these women are socially aware of the risk of diseases of overconsumption of them, probably due to having greater access to nutritional information and their level of education, although it would be wise to consider the quality of the fat, because as will be seen below, cholesterol levels are increased.

It is well documented that excessive intake of protein increases urinary excretion of calcio^{17,18} may have significant impact on the health of postmenopausal women presenting progressive bone loss, however, reciente¹⁹ study has shown that this excess protein in the diet does not affect bone status.

As for the intake of the major minerals involved in bone metabolism, our results show adaptation to nutritional needs in calcium and high in phosphorus, an important fact that must be taken into account, since

excessive drinking to be present in high percentage foods may decrease intestinal absorption of calcium and magnesium²⁰, affecting bone density.

Regarding magnesium intake, postmenopausal women have lower than recommended media in a high percentage, as can be seen in several studies^{21,16}, noting that women have higher age range increased intake of magnesium, possibly due to increased intake of foods rich in magnesium or greater energy intake.

In our study, insufficient intake of magnesium through diet corresponds to 36% of the sample (fig. 2), this group is quite large when you consider that the study was conducted in a developed area where supply and food availability is high.

Several authors have shown that magnesium deficiency in menopausal women was associated with an increased IMC^{22,9}. In our study, insufficient intake of magnesium is associated with increased waist/hip ratio, which could lead to a situation similar to those cited.

In our study, practically all biochemical values are within the normal range in both age groups, highlighting the plasma levels of prealbumin, located on the edge, correlated with intake of magnesium deficiency in our study. The plasma magnesium is one more readily available for use in its multiple functions, so these results may inform you to depletions prealbumin,

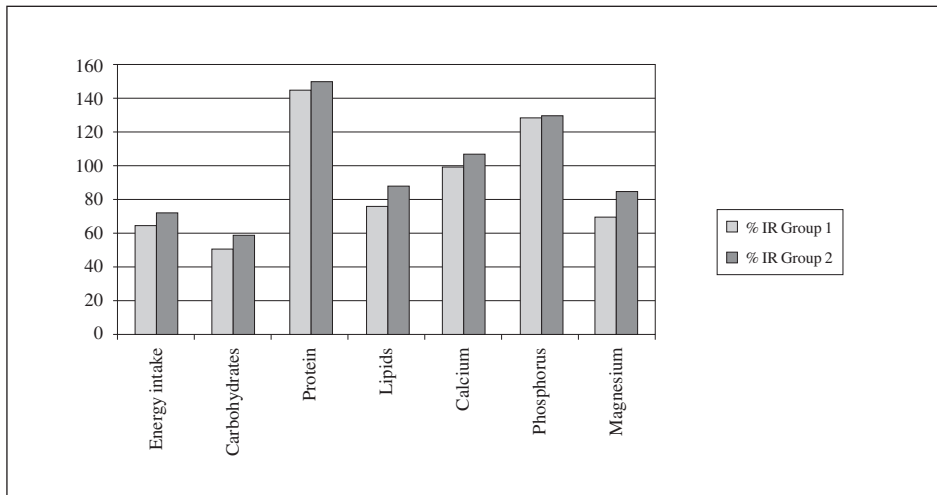


Fig. 1.—Percentage of intake of macronutrients and minerals in relation to the RDA in both age groups.

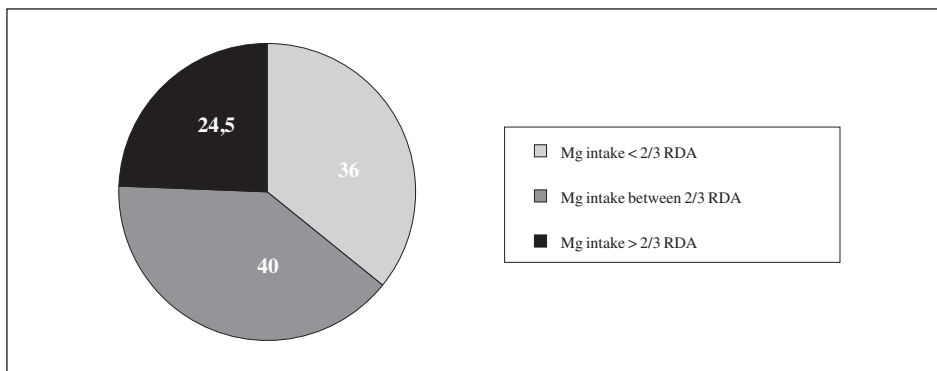


Fig. 2.—Percentage of intakes of magnesium in the total sample.

are released higher amounts of magnesium, for example to act in situations of increased oxidative stress which may occur in the postmenopausal stage.

Our results show that a high percentage of the sample (fig. 3) provides adequate levels of magnesium in plasma and approximately a third of the population has some blood magnesium levels below the reference value, similar results to those obtained by Laires et al (2004)¹⁶, so we can say that postmenopausal women in our study have a magnesium deficiency in erythrocyte considerably, probably due to insufficient intake of magnesium and deregulation of the factors controlling Mg homeostasis during menopause.

This decrease in erythrocyte magnesium levels possibly due to increased physiological demands at this stage of the woman, which leads to depletion in this compartment.

Considering the direct correlation between the Mg-erythrocyte and triglyceride levels, there appears to be direct cardiovascular risk in our women, but would have to take into account other lipid profiles such as cholesterol, high in our women, although this relationship may also be due to the involvement of both the insulin pathway. Other studies, such as that conducted by Farhangi et al (2011)²³, determined in a group of postmenopausal women no correlation between erythrocyte Mg and triglyceride levels.

Numerous studies have demonstrated that postmenopausal osteoporosis is often associated with a low dietary intake of magnesium and reducing Mg levels in the serum and bone^{24,25}. In our study we have not been able to assess whether magnesium deficiency may contribute to osteoporosis, but if we observe that body magnesium levels measured in plasma and erythrocyte are deficient in many cases and may be a risk factor for the occurrence of osteoporosis with higher incidence during this stage postmenopausal.

Conclusions

We conclude that at this menopausal stage is very important proper nutritional intake, both to maintain optimal levels of nutrients, such as to maintain a proper

body weight, so as to counteract the increased risk of several pathologies associated with this status. The data show that both age groups of women have low nutritional intake.

As for magnesium intake found in our population is insufficient in 36% of women, with a higher intake in women of upper age range, while plasma magnesium deficiency corresponds to 23% of the population, being in both groups of similar age and 72% of women have lower levels of magnesium in erythrocyte.

Our results confirm the need for control and monitoring of mineral status, particularly magnesium, given its functional spectrum and greater needs, in postmenopausal women. The high prevalence of deficiencies found in this element as essential to good health osteo –muscular, nervous, antioxidant, immune, etc., leads us to emphasize the importance of an intervention with nutrition education and healthy habits in this group as vulnerable because the inevitable suffering drastic changes at this age.

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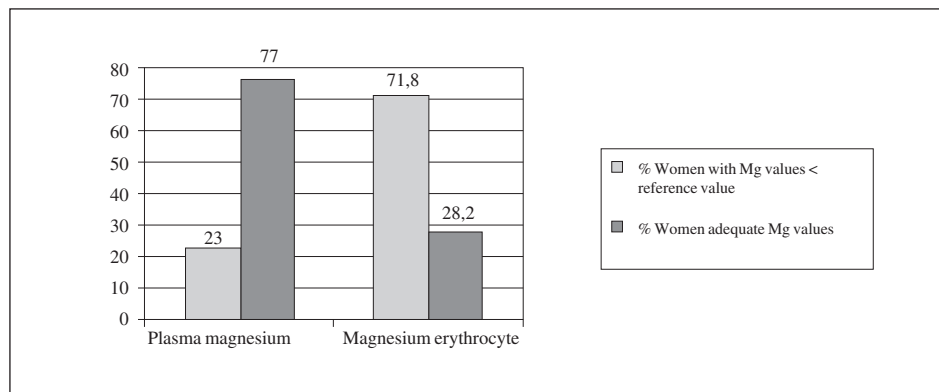


Fig. 3.—Percentage of population with magnesium values in plasma and erythrocytes appropriate and inappropriate.

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