

Original

Mineral inadequacy of oral diets offered to patients in a Brazilian hospital

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Abstract

Introduction: While enteral diets for hospitalized patients normally follow nutrient composition guidelines, more than 90% of hospitalized patients receive oral diets with unknown mineral composition.

Objective: To evaluate the mineral contents and adequacy of three types of oral diets (regular, blend and soft) and complementary snacks offered to patients of a Brazilian hospital.

Methods: The amount of minerals was determined in two non-consecutive days in duplicate samples of breakfast, collation, lunch, snack, dinner, supper and a complementary snack meal. Dietary Reference Intakes (DRIs) were used to determine the adequacy of the daily amounts served to patients.

Results and discussion: The regular diet met the RDA (Recommended Dietary Allowances) requirements only for Mn, P and Se, while the blend diet was deficient in Ca, K and Mg, and the soft diet met RDA requirements only for P and Zn. Iron was below the RDA requirement in all diets for women in fertile age, and Na was above the safe limit of intake (UL) in all the diets. The use of complementary snack was effective in meeting RDA requirements for Cu in the regular diet, and Mn and Se in the soft diet, but promoted overconsumption of Na.

Conclusions: Evident nutritional imbalances have been detected at a key interphase between nutrition and public health services, but a solution does not appear to be insurmountable. A permanent nutritional evaluation of hospital oral diets should be an integral part of routine health care in order to speed the recovery of the hospitalized patient and dispel eventual risks due to critical mineral imbalances.

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Key words: Mineral content. Nutritional recommendation. Sodium. Food analysis. Diet therapy.

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GRADO DE INADECUACIÓN EN MINERALES DE DIETAS ORALES OFRECIDAS A PACIENTES EN HOSPITAL BRASILEÑO

Resumen

Introducción: Mientras las dietas enterales para pacientes hospitalizados siguen normas de composición nutricional, más del 90% de los pacientes internados en Latinoamérica reciben dietas orales de composición mineral desconocida.

Objetivo: Evaluar el contenido mineral y la adecuación de tres tipos de dietas orales (regular, blanda y fluida) y meriendas complementarias ofrecidas a los pacientes de un hospital brasileiro.

Métodos: La cantidad de minerales fue determinada en dos días no consecutivos, en duplo muestreo de desayuno, onces, almuerzo, merienda, cena y una merienda complementaria. Se usaron los Dietary Reference Intakes (DRIs) para determinar los grados de adecuación de cada porción diaria servida.

Resultados y discusión: La dieta regular cumplió con la RDA (Recommended Dietary Allowances) solamente para Mn, P and Se. En cambio, la dieta blanda fue deficiente en Ca, K and Mg, y la dieta fluida cumplió con la RDA apenas para P and Zn. Sin embargo, el hierro permaneció abajo de la RDA en todas las dietas para mujeres en edad fértil, contrastando con el and Na, que se encontraba arriba del límite de seguridad (UL) en todas dietas. El apelo a meriendas complementarias fue un recurso que permitió alcanzar las exigencias de las RDA para Cu en la dieta regular, y Mn y Se en la dieta fluida.

Conclusión: Desbalances nutricionales se hicieron evidentes en la interfase nutrición-servicios de salud pública, cuya solución no es insuperable. La evaluación nutricional de dietas orales de hospitales debería ser parte integral de la rutina en los servicios de salud para garantizar la más rápida recuperación de los pacientes e, inclusive, para minimizar los riesgos de agravamiento debidos a desbalances críticos de minerales.

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Palabras clave: Tenor mineral. Recomendaciones nutricionales. Sodio. Análisis de alimentos. Dietoterapia.

Abbreviations

Ca: Calcium.
Mg: Magnesium.
Mn: Manganese.
P: Phosphorus.
Fe: Iron.
Na: Sodium.
K: Potassium.
Cu: Copper.
Zn: Zinc.
Se: Selenium.
RDA: Recommended Dietary Allowances.
UL: Upper Intake Levels.
AI: Adequate Intakes.
DRIs: Dietary Reference Intakes.
IOM: Institute of Medicine.
ICP OES: Inductively Coupled Plasma Optical Emission Spectroscopy.
NIST: National Institute of Standards and Technology.
ANOVA: Analysis of variance.
ADA: American Dietetic Association.

Introduction

Studies on the nutrient composition of hospital diets deal mainly with enteral and parenteral diets, or even nutritional supplements, leaving a gap in terms of oral hospital diets, and particularly with respect to minerals.¹ On the other hand, oral hospital diets have been routinely prescribed to more than 90% of all hospitalized patients in Latin America.² Diets can have their texture altered, for example, so as to provide special physico-chemical properties, as in the case of patients with deglutition or chewing difficulties,¹ but such alterations may adversely affect the amount of nutrients, including minerals, of the oral diets.^{3,4}

Essential minerals can have a protective effect against diseases such as cancer⁵ and illnesses can develop in case of low intakes,⁶ but could be toxic if in excess.⁷ Therefore, considering the risks that may result from both, deficiencies and toxicities, the daily recommendations for minerals should be judiciously followed in order to avoid jeopardize the individual's nutritional balance,⁸ especially when under hospital care.

However, calculation of the amounts of minerals in diets and meals, food composition tables are invariably used,¹ but the calculation of nutrients by tables is subject to some limitations that can lead to significantly imprecise estimates for the ingredients used in the recipes, mainly spices, oils and fats.⁹ Such errors can ultimately result in the incorrect delivery of nutrients, and even misleading conclusions about the relationship between diet and disease.¹⁰

Although adequate mineral nutrition may be vitally important to the health of a hospitalized patient, knowledge gaps regarding the components of oral hospital diets are identified in practice. Therefore, this study

aimed at determining the amounts of calcium (Ca), magnesium (Mg), manganese (Mn), phosphorus (P), iron (Fe), sodium (Na), potassium (K), copper (Cu), zinc (Zn) and selenium (Se), in oral hospital diets with distinct textures (regular, blend and soft), and assessing its adequacy in relation to the Dietary Reference Intake (DRIs),¹¹ with or without prescription of a complementary snack meal.

Materials and methods

This pilot study evaluated in two non-consecutive days the amounts of Ca, Cu, Fe, K, Mg, Mn, Na, P, Zn and Se in the meals making up the regular, blend and soft diets, produced at the Food and Nutrition Section of the Mário Penna Association Hospital of Belo Horizonte, MG, Brazil. The evaluated diets varied in consistency, but were routinely prescribed in general hospitals and hospitals for the treatment of patients of specific pathologies.

All three types of diets had six meals each (breakfast, collation, lunch, snack, dinner and supper). Regular diet breakfast consisted of bread with margarine, milk with coffee and sugar, and a piece of fruit; collation or morning snack consisted of a cup of industrialized juice; lunch was composed by a tossed salad, rice and beans, a piece of meat (pork or beef), vegetable or white beans and fruits for desert; the snack consisted of bread with margarine, milk with coffee and sugar, cookie or a fruit smoothie with sugar; dinner consisted of a mix of rice with red meat and vegetables or pasta with Bolognese sauce, and for supper or night snack, strawberry yogurt or oatmeal was served.

The blend diet menu was similar to the regular diet, except for some changes in the food texture, changing the bread, vegetables and fruit types. For the soft diet, all menus were adapted to be very soft, and it included additional mashed potatoes or mashed pumpkins or mashed carrots, soups, ground red meat, very soft fruits like papaya and banana.

In order to meet certain patients' needs, dietitians offered a complementary snack prescription at collation time and/or snack time, using a mixed combination of products like cereal, fruit and regular milk in the form of a smoothie. The daily values for each mineral in every diet, with and without complementary snacks, were compared with the DRIs for healthy adult and elderly patients of both genders (table I).¹¹

Sample collection

Duplicate samples of breakfast; collation; lunch; snack; dinner and supper on two non-consecutive days (Tuesday and Thursday) were collected in May 2010. On those days the employees of the institution prepared two additional units of the meals of interest for the study, in a way that was similar to that used in the frac-

Table I
Nutritional recommendations for the minerals Ca, Cu, Fe, K, Mg, Mn, Na, P, Zn and Se according to the Dietary Reference Intake (DRIs)¹¹

| Mineral (mg/d) | RDA [#] | | | | | | | | UL [*] |
|-------------------|------------------|---------|---------|--------|---------|---------|---------|--------|--------------------|
| | Male | | | | Female | | | | Male and female |
| | 19-30 y | 31-50 y | 51-70 y | > 70 y | 19-30 y | 31-50 y | 51-70 y | > 70 y | > 19 years |
| Ca* | 1,000 | 1,000 | 1,200 | 1,200 | 1,000 | 1,000 | 1,200 | 1,200 | 2,500 |
| Cu | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 10 |
| Fe | 8 | 8 | 8 | 8 | 18 | 18 | 8 | 8 | 45 |
| K* | 4,700 | 4,700 | 4,700 | 4,700 | 4,700 | 4,700 | 4,700 | 4,700 | ND [*] |
| Mg | 400 | 420 | 420 | 420 | 310 | 320 | 320 | 320 | 350 ^{**} |
| Mn | 2.3 | 2.3 | 2.3 | 2.3 | 1.8 | 1.8 | 1.8 | 1.8 | 11 |
| Na* | 1,500 | 1,500 | 1,300 | 1,200 | 1,500 | 1,500 | 1,300 | 1,200 | 2,300 |
| P | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 700 | 4,000 |
| Zn | 11 | 11 | 11 | 11 | 8 | 8 | 8 | 8 | 40 |
| Se | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 | 0.4 |

[#]RDA = Recommended Dietary Allowances.

^{*}UL = Upper Intake Levels.

^{*}AI = Adequate Intakes.

^{*}Not available.

^{**}Value represents intake from pharmacological supplements only, not including intake from food or water.

tionation of the meals prepared for the patients. The sampling took place at the regular meal times.

Each meal collected was weighed on an electronic scale with sensitivity in grams (Filizola, Pluris Top). The samples were homogenized in a multiprocessor equipped with a rigid plastic blade. A sample of 50 g was separated, stored in zipper-lock bags, labeled and frozen (-18°C). Finally, the samples were stored in isothermal boxes containing recyclable ice and forwarded to the chemical analyses laboratory.

The values of daily intake, Recommended Dietary Allowances (RDA) or Adequate Intakes (AI), as well as the Upper Intake Levels (UL) recommended by the Institute of Medicine (IOM) for the minerals analyzed were used as a reference for adults and elderly of both genders. For the purpose of this study, an adult was an individual between 19 and 59 years old, and an elderly was an individual > 60 years old. The percentage of adequacy of each mineral supplied by the regular, blend and soft diets, alone or combined with a complementary snack, was calculated for each gender and age group. When there was a difference in the daily recommendation for the mineral within the age group, we adopted the highest value of the recommendation, for as long as it did not exceed the UL.

Reagents and Standards curves

All reagents were analytical grade reagents. High purity deionized water (resistivity 18.2 MΩ) obtained using the Milli-Q water purification system (Millipore, Bedford, MA, USA) was used throughout. All glass-

ware was cleaned by soaking in 20% (v/v) HNO₃ for three hours, rinsed three times with Milli-Q water and dried before use.

For the standard curves, a multi element standard solution was prepared in 5% HCl (v/v) from stock solutions of 10,000 mg/L of Ca, K, Mg, Na (Merck, Darmstadt, Germany) and at 1,000 mg/L for Cu, Mn, Fe, Se, Zn (Merck, Darmstadt, Germany). The concentration ranges of the standard solutions were: 0.01 to 1 mg/L of Cu, Fe, Mn and Zn; 1.01 to 101 mg/L of Ca, Mg, K, P and Na; 0.01 to 0.5 mg/L of Se.

Sample Digestion

Calcium, potassium, magnesium, manganese, phosphorus, copper, zinc

Five grams of sample (wet weight) were weighed into porcelain crucibles and incinerated in a furnace at 450 °C for 10 hours. The ashes were dissolved in 2.5 mL of concentrated hydrochloric acid (Merck, Darmstadt, Germany) and diluted to 25 mL with deionized water in volumetric flasks. Analyses were carried out in duplicate.¹²

Iron

Two grams of sample were transferred into 25 ml volumetric flasks and 5 mL concentrated hydrochloric acid (Merck, Darmstadt, Germany) were added. The volumetric flasks were shaken for 2 hours in an orbital

shaker and after this period, the extract was diluted to level with deionized water. It was then filtered through a quantitative filter paper. Determinations were carried out in duplicate.¹³

Selenium

Two grams of homogenized sample were weighed into a 100 mL beaker, 25 mL of concentrated nitric acid (Merck, Darmstadt, Germany) were added and the suspension heated up to 180°C for 2h on a hot plate. The extract was cooled and 7 mL of hydrogen peroxide (Merck, Darmstadt, Germany) were added. The extract was gradually heated to 180°C until the volume was reduced to about 10 mL. The solution was cooled and quantitatively transferred to a 25 mL volumetric flask. The volume was completed with a hydrochloric acid solution 5% (v/v).¹⁴

Sample blanks were prepared in the laboratory in a similar manner to that of the field samples for all methodologies.

Instrumentation

Quantification of mineral elements was performed by inductively coupled plasma optical emission spectroscopy (ICP OES), using a VARIAN, model Vista MPX (Mulgrave, Australia), equipped with a radiofrequency source (RF) of 40 MHz, a simultaneous multi element detector of solid state type CCD (Charge Coupled Device), peristaltic pump, nebulizing chamber, and a nebulizer sea spray. The system was controlled by the software ICP Expert, utilizing argon with purity of 99.996% (Air Liquid, SP, Brazil) both as plasma liquid and auxiliary gas. The operating conditions were: potency, 1000 W; nebulizing rate, 0.9 L/min; flow rate of argon and the auxiliary gas, 1.5 and 15 L/min; integrating and reading times, 10 and 3 s; number of replicates, 3. The wavelengths (nm) used were: Ca, 317.933 nm; Cu, 324.754 nm; Fe, 259.940 nm; K, 766.491 nm; Mg, 279.553 nm; Mn, 257.610; Na, 589.592 nm; P, 213.618 nm; Zn, 206.200 nm and Se, 196.026.

Quality assurance

All analytical methods were developed and validated for precision and accuracy by means of reference material analysis with certified values for the elements determined: Typical Diet (1548a), of the National Institute of Standards and Technology (NIST).

Statistical analysis

The Stata/MP 11.1 for Mac (StataCorp®) was employed for data analysis. Results are expressed as arithmetic

mean and standard deviation. The normal distribution of variables was checked by the Shapiro-Wilk test. The comparisons were done using the Student's t-test and analysis of variance (ANOVA) for parametric conditions and the Kruskal-Wallis test when conditions were non-parametric. Means were compared using the Tukey's test or Mann Whitney U test, respectively. Level of significance was set at $p < 0.05$.

Results

The accuracy and precision of our results were checked against analyzed certified reference material Typical Diet 1548a (NIST). Eight repetition analyses were performed for these analytical procedures. The results showed compatibility between the certified and the analytical values, and the recovery of mineral elements was complete for most of them. For all elements the results of the accuracy varied from 84 to 104%, and the precision varied from 3 to 10%.

The values of minerals supplied by the hospital meals that make up each of the three diets analyzed are shown in table II. The regular, blend and soft diets exhibited differences in the total daily amounts of Ca, Cu, K, Mg, Mn and Na ($p < 0.05$). Except for Se, the types of meals differed ($p < 0.05$) in the amounts of minerals supplied for breakfast, while collation and supper were equivalent in their mineral supply. In the lunch, except for K, all minerals exhibited differences between diets ($p < 0.05$). The largest differences among the diets ($p < 0.03$) occurred with regard to calcium and sodium, particularly between snacks and dinners. The amounts of Ca, Fe, Mg, Na and Zn in snacks ($p < 0.01$) and, Ca, Cu, K, Mg, Na and P in dinners, showed differences between diets ($p < 0.01$).

In relation to the complementary snack, table III shows that the level of minerals provided by the complementary snack meal differed in the levels of Ca, Cu, Fe, K, and Mn, comparing the morning and afternoon prescriptions. The amount of Mn was on average two times higher in the complementary snack offered in the afternoon.

Table IV exhibits the amounts of minerals supplied by the regular, blend and soft diets, alone or combined with the complementary snack. This table also compares the mineral supply with the Dietary Reference Intakes (DRIs) showing the percentage of adequacy that results from both the diet alone and the diet associated with the complementary meal for both genders and age groups. In a general manner, table V carries the mineral mean value delivered by each diet and evaluates its adequacy by comparing with the corresponding RDI.

The regular diet met the RDA for Mn, P and Se for both genders and age groups, and for Mg for adult and elderly females. Calcium, K and Zn, on the other hand, were below the recommended levels for both genders and age groups, while Fe was inadequate for adult

Table II
Amount of minerals supplied by each meal through the regular, blend and soft diets

| Element | Diet | Mean \pm SD | | | | | | |
|---------|---------|---------------------------------|-------------------|-----------------------------------|----------------------------------|------------------------------------|--------------------|------------------------------------|
| | | Breakfast | Collation | Lunch | Snack | Dinner | Supper | Total Daily |
| Ca | Regular | 160.34 \pm 2.25 ^b | 7.16 \pm 1.36 | 62.97 \pm 8.24 ^c | 139.24 \pm 26.62 ^b | 26.93 \pm 4.44 ^b | 108.02 \pm 69.67 | 504.67 \pm 55.58 ^b |
| | Blend | 198.63 \pm 5.38 ^b | 7.16 \pm 1.36 | 54.22 \pm 2.26 ^b | 157.12 \pm 27.45 ^b | 120.29 \pm 76.94 ^b | 108.02 \pm 69.67 | 645.44 \pm 36.96 ^b |
| | Soft | 348.17 \pm 55.05 ^a | 7.16 \pm 1.36 | 82.48 \pm 16.81 ^a | 313.21 \pm 26.25 ^a | 81.20 \pm 12.18 ^a | 108.02 \pm 69.67 | 940.24 \pm 60.66 ^c |
| Cu | Regular | 0.13 \pm 0.07 ^a | 0.03 \pm 0.02 | 0.41 \pm 0.07 ^a | 0.09 \pm 0.02 | 0.19 \pm 0.02 ^b | nd | 0.85 \pm 0.03 ^a |
| | Blend | 0.11 \pm 0.01 ^a | 0.03 \pm 0.02 | 0.41 \pm 0.04 ^b | 0.07 \pm 0.03 | 0.32 \pm 0.02 ^a | nd | 0.93 \pm 0.05 ^a |
| | Soft | 0.07 \pm 0.03 ^b | 0.03 \pm 0.02 | 0.29 \pm 0.04 ^b | 0.06 \pm 0.02 | 0.22 \pm 0.04 ^b | nd | 0.66 \pm 0.08 ^b |
| Fe | Regular | 3.35 \pm 0.39 ^a | 0.14 \pm 0.09 | 3.71 \pm 0.87 ^b | 2.09 \pm 0.92 ^a | 4.57 \pm 3.79 | 0.10 \pm 0.07 | 13.97 \pm 3.91 |
| | Blend | 1.12 \pm 0.17 ^b | 0.14 \pm 0.09 | 4.73 \pm 0.37 ^a | 1.15 \pm 0.27 ^b | 3.47 \pm 0.36 | 0.10 \pm 0.07 | 10.71 \pm 0.48 |
| | Soft | 3.99 \pm 1.71 ^a | 0.14 \pm 0.09 | 3.09 \pm 0.87 ^b | 3.55 \pm 1.57 ^a | 3.90 \pm 2.36 | 0.10 \pm 0.07 | 14.76 \pm 3.52 |
| K | Regular | 394.30 \pm 16.70 ^b | 22.70 \pm 15.26 | 889.90 \pm 86.16 | 372.38 \pm 160.36 | 323.84 \pm 35.05 ^c | 157.58 \pm 93.76 | 2,160.71 \pm 23.55 ^b |
| | Blend | 457.64 \pm 21.89 ^a | 22.70 \pm 15.26 | 938.95 \pm 83.94 | 395.80 \pm 146.65 | 616.64 \pm 44.05 ^a | 157.58 \pm 93.76 | 2,589.33 \pm 85.49 ^a |
| | Soft | 353.64 \pm 24.00 ^b | 22.70 \pm 15.26 | 941.62 \pm 213.22 | 387.64 \pm 92.18 | 537.74 \pm 55.13 ^b | 157.58 \pm 93.76 | 2,400.94 \pm 274.07 ^b |
| Mg | Regular | 67.15 \pm 3.08 ^b | 3.82 \pm 1.36 | 127.69 \pm 14.75 ^b | 64.08 \pm 24.46 ^a | 57.26 \pm 7.68 ^a | 19.87 \pm 12.19 | 339.86 \pm 5.89 ^a |
| | Blend | 38.29 \pm 2.26 ^b | 3.82 \pm 1.36 | 68.21 \pm 6.60 ^b | 33.75 \pm 12.40 ^a | 47.93 \pm 0.99 ^b | 19.87 \pm 12.19 | 211.86 \pm 9.57 ^b |
| | Soft | 29.81 \pm 0.81 ^c | 3.82 \pm 1.36 | 65.20 \pm 18.56 ^b | 31.57 \pm 9.29 ^b | 42.75 \pm 2.45 ^c | 19.87 \pm 12.19 | 193.02 \pm 20.10 ^b |
| Mn | Regular | 0.40 \pm 0.05 ^c | 0.03 \pm 0.02 | 1.70 \pm 0.08 ^a | 0.42 \pm 0.11 | 0.90 \pm 0.41 | 0.01 \pm 0.01 | 3.46 \pm 0.54 ^a |
| | Blend | 0.55 \pm 0.26 ^b | 0.03 \pm 0.02 | 1.28 \pm 0.05 ^b | 0.29 \pm 0.11 | 0.71 \pm 0.03 | 0.01 \pm 0.01 | 2.87 \pm 0.19 ^a |
| | Soft | 0.21 \pm 0.07 ^b | 0.03 \pm 0.02 | 0.65 \pm 0.18 ^c | 0.23 \pm 0.11 | 0.57 \pm 0.07 | 0.01 \pm 0.01 | 1.71 \pm 0.13 ^b |
| Na | Regular | 606.84 \pm 51.18 ^a | 7.79 \pm 2.23 | 2,036.4 \pm 282.20 ^b | 422.75 \pm 169.62 ^a | 1,519.88 \pm 162.57 ^a | 81.98 \pm 41.13 | 4,675.62 \pm 355.54 ^a |
| | Blend | 333.14 \pm 25.26 ^b | 7.79 \pm 2.23 | 2106.9 \pm 64.22 ^a | 265.61 \pm 6.64 ^b | 1,391.84 \pm 251.82 ^a | 81.98 \pm 41.13 | 4,187.28 \pm 164.24 ^b |
| | Soft | 148.64 \pm 9.06 ^c | 7.79 \pm 2.23 | 1,427.6 \pm 263.43 ^b | 158.41 \pm 23.37 ^c | 766.66 \pm 48.21 ^b | 81.98 \pm 41.13 | 2,591.05 \pm 263.43 ^c |
| P | Regular | 208.97 \pm 9.47 ^c | 2.23 \pm 1.09 | 322.96 \pm 20.71 ^a | 187.60 \pm 35.24 | 202.13 \pm 50.49 ^b | 104.88 \pm 63.45 | 1,028.77 \pm 47.62 |
| | Blend | 236.03 \pm 2.16 ^b | 2.23 \pm 1.09 | 329.62 \pm 10.51 ^a | 195.63 \pm 36.94 | 328.73 \pm 90.55 ^a | 104.88 \pm 63.45 | 1,197.13 \pm 60.26 |
| | Soft | 258.70 \pm 31.63 ^a | 2.23 \pm 1.09 | 190.30 \pm 34.53 ^b | 252.84 \pm 33.40 | 165.82 \pm 20.93 ^b | 104.88 \pm 63.45 | 974.76 \pm 75.56 |
| Zn | Regular | 1.14 \pm 0.05 ^c | 0.03 \pm 0.02 | 2.81 \pm 0.63 ^b | 1.06 \pm 0.27 ^b | 2.24 \pm 0.76 | 0.47 \pm 0.29 | 7.76 \pm 1.41 |
| | Blend | 1.34 \pm 0.01 ^b | 0.03 \pm 0.02 | 4.79 \pm 1.81 ^a | 1.11 \pm 0.24 ^b | 4.46 \pm 1.59 | 0.47 \pm 0.29 | 12.21 \pm 0.81 |
| | Soft | 4.11 \pm 0.94 ^a | 0.03 \pm 0.02 | 2.64 \pm 0.31 ^b | 3.15 \pm 0.40 ^a | 3.57 \pm 1.81 | 0.47 \pm 0.29 | 13.98 \pm 2.28 |
| Se | Regular | na | na | na | na | na | na | 0.06 \pm 0.03 |
| | Blend | na | na | na | na | na | na | 0.07 \pm 0.02 |
| | Soft | na | na | na | na | na | na | 0.04 \pm 0.03 |

Nd: Below detection level; ^{a,b,c} Different letters in the same column indicate significant differences for the same element in the three diets meal ($p < 0.05$).

Table III
Amount of minerals provided by complementary snacks

| Element (mg) | Morning complementary snack | Afternoon complementary snack | Total Daily |
|--------------|-----------------------------|-------------------------------|---------------|
| Calcium | 19.54 ± 1.77* | 16.86 ± 1.13* | 36.40 ± 1.99 |
| Copper | 0.05 ± 0.01* | 0.08 ± 0.01* | 0.13 ± 0.02 |
| Iron | 0.45 ± 0.15* | 0.95 ± 0.27* | 1.40 ± 0.38 |
| Potassium | 22.17 ± 0.13* | 20.28 ± 1.26* | 42.45 ± 1.17 |
| Magnesium | 2.34 ± 0.32 | 2.71 ± 0.26 | 5.05 ± 0.50 |
| Manganese | 0.22 ± 0.09* | 0.44 ± 0.08* | 0.66 ± 0.16 |
| Sodium | 77.00 ± 6.27 | 73.15 ± 4.40 | 150.15 ± 9.88 |
| Phosphorus | 15.98 ± 1.15 | 16.07 ± 1.47 | 32.04 ± 2.04 |
| Zinc | 0.83 ± 0.15 | 0.53 ± 0.48 | 1.35 ± 0.30 |
| Selenium | 0.05 ± 0.03 | 0.07 ± 0.02 | 0.13 ± 0.04 |

*Signifies a significant difference between offered periods ($p < 0.05$). (Mean ± SD).

females. Sodium was the only one mineral whose level was above the UL, and the amount was even higher when including the complementary snack, which was essential to attain adequacy in Cu. The regular diet supplied a higher amount of Cu and Mn than the soft diet ($p < 0.05$), in addition to supplying more Mg and Na than the soft and the blend diets ($p < 0.01$). However, the regular ranked lowest in Ca ($p = 0.008$) (tables IV and V).

The blend diet offered the best supply of minerals, except for Ca, K and Mg that were below recommendations for both genders and age groups, while the Fe concentration was inadequate for adult women. No mineral exceeded the UL value, except for Na. The blend diet supplied less Ca than the soft diet ($p < 0.02$), but more Cu, Mn and Na than the soft diet ($p < 0.05$). It also presented a lower amount of Mg ($p = 0.007$) and more K than the regular diet (tables IV and V).

The soft diet presented the highest number of mineral inadequacies according to the RDAs. The values of Ca, Cu, K, Mg, Mn and Se were below those recommended for both genders and age groups. The amount of Fe was also insufficient for adult women. Compared with others, this diet showed the lowest amounts of Cu, K, Mn, Mg and Na ($p < 0.05$) and less Mg than regular diet ($p = 0.005$), but the highest amounts of Ca ($p < 0.02$). Only the level of Na was above the UL (tables IV and V).

Discussion

Few studies have analyzed minerals in hospital diets on a meal-by-meal basis that could be used to compare with the results of the present survey. Study evaluated the amount of Mn in breakfast, lunch and dinner in the hospital of Motril (Spain). The average amounts of Mn supplied by the meals were as follows: breakfast, 0.67 mg; lunch, 1.45 mg; and dinner, 0.98 mg. The study also detected that the mean daily intake of Mn was 3.05

mg.¹⁵ Those values were similar to those observed in the regular and blend diets of the present study (Table II). We should highlight the fact that the total daily supply of Mn was similar, even though the number of meals that comprised the diets was different. The patients in the present study received three additional meals (collation, complementary snack and supper). However, low levels of Mn were detected in the collation and supper, thus permitting the results to be similar.

In 2005, the American Dietetic Association (ADA) took a stand in relation to the use of nutrients oral supplementation, stating that its use might help some individuals meet their nutritional needs when their diet does not supply adequate amounts of vitamins and minerals. The document also mentions the importance of fractioning the nutrient supply due to the fact that absorption tends to be higher when nutrients are offered in smaller doses and higher frequency, rather than in a single dose.¹⁶ Therefore, the two distinct schedules for the complementary snack adopted by the Belo Horizonte hospital, can be helpful for the patient's general state of health.

The prescription of complementary snack is often designed for patients who receive the blend or soft diets, including those with impaired deglutition capacity. The regular diet is prescribed to patients who do not need texture alterations while the blend diet comprises foods in which the tissues are softened by mechanical action or cooking to facilitate the chewing and digestion. The soft diet, on the other hand, comprises even softer foods than the blend diet, with predominantly liquid foods, very soft or mashed foods, and is offered to individuals who have chewing or deglutition difficulties and cannot ingest foods with double consistency or thin liquids.

Consistency alterations of blend and soft diets often results in the modification (dilution) of the nutrient content.¹⁷ Therefore, studies suggest that modified consistency diets may contribute to the nutritional inadequacy for the patient, that is, they do not supply enough nutrients.^{3,4}

Table IV
Percentage of adequacy of minerals supplied by the regular, blend and soft diets, alone or combined with complementary snack (CS), according to nutritional recommendations by gender and age groups

| Mineral | % of adequacy of supply to RDA# | | | | | | | | | |
|------------|---------------------------------|------------------------|-------|------------|---------|--------------|--------|------------|---------|--------------|
| | Regular Diet | | | | | | | | | |
| | Mean daily supply (mg) | | Male | | | | Female | | | |
| | Regular | Regular + CS* | Adult | Adult + CS | Elderly | Elderly + CS | Adult | Adult + CS | Elderly | Elderly + CS |
| Ca** | 504.7 ^b | 541.07 ^b | 50.5 | 54.1 | 42.1 | 45.1 | 50.5 | 54.1 | 42.1 | 45.1 |
| Cu | 0.8 ^{ax} | 0.98 ^{ay} | 93.5 | 108.5 | 93.5 | 108.5 | 93.5 | 108.5 | 93.5 | 108.5 |
| Fe | 14.0 | 15.36 | 174.6 | 192.0 | 174.6 | 192.0 | 77.6 | 85.4 | 174.6 | 192.0 |
| K** | 2,160.7 ^{bx} | 2,203.17 ^{by} | 46.0 | 46.9 | 46.0 | 46.9 | 46.0 | 46.9 | 46.0 | 46.9 |
| Mg | 339.9 ^a | 344.91 ^a | 80.9 | 82.1 | 80.9 | 82.1 | 106.2 | 107.8 | 106.2 | 107.8 |
| Mn | 3.5 ^a | 4.12 ^a | 150.5 | 179.0 | 150.5 | 179.0 | 192.3 | 228.8 | 192.3 | 228.8 |
| Na** | 4,675.6 ^a | 4,825.76 ^a | 311.7 | 321.7 | 359.7 | 371.2 | 311.7 | 321.7 | 359.7 | 371.2 |
| P | 1,028.8 | 1,060.8 | 147.0 | 151.5 | 147.0 | 151.5 | 147.0 | 151.5 | 147.0 | 151.5 |
| Zn | 7.8 | 9.11 | 70.5 | 82.9 | 70.5 | 82.9 | 97.0 | 113.9 | 97.0 | 113.9 |
| Se | 0.06 | 0.07 | 107.3 | 130.9 | 107.3 | 130.9 | 107.3 | 130.9 | 107.3 | 130.9 |
| Blend Diet | | | | | | | | | | |
| | Bland | Bland + CS* | | | | | | | | |
| Ca** | 645.4 ^b | 681.8 ^b | 64.5 | 68.2 | 53.8 | 56.8 | 64.5 | 68.2 | 53.8 | 56.8 |
| Cu | 0.9 ^{ax} | 1.1 ^{ay} | 103.0 | 118.0 | 103.0 | 118.0 | 103.0 | 118.0 | 103.0 | 118.0 |
| Fe | 10.7 ^a | 12.1 ^a | 133.9 | 151.3 | 133.9 | 151.3 | 59.5 | 67.2 | 133.9 | 151.3 |
| K** | 2,589.3 ^a | 2,631.8 ^a | 55.1 | 56.0 | 55.1 | 56.0 | 55.1 | 56.0 | 55.1 | 56.0 |
| Mg | 211.9 ^b | 216.9 ^b | 50.4 | 51.6 | 50.4 | 51.6 | 66.2 | 67.8 | 66.2 | 67.8 |
| Mn | 2.9 ^{ax} | 3.5 ^{ay} | 124.7 | 153.3 | 124.7 | 153.3 | 159.3 | 195.8 | 159.3 | 195.8 |
| Na** | 4,187.3 ^b | 4,337.4 ^b | 279.2 | 289.2 | 322.1 | 333.6 | 279.2 | 289.2 | 322.1 | 333.6 |
| P | 1,197.1 | 1,229.2 | 171.0 | 175.6 | 171.0 | 175.6 | 171.0 | 175.6 | 171.0 | 175.6 |
| Zn | 12.2 ^a | 13.6 ^a | 111.0 | 123.3 | 111.0 | 123.3 | 152.6 | 169.5 | 152.6 | 169.5 |
| Se | 0.07 | 0.08 | 120.0 | 143.6 | 120.0 | 143.6 | 120.0 | 143.6 | 120.0 | 143.6 |
| Soft Diet | | | | | | | | | | |
| | Soft | Soft + CS* | | | | | | | | |
| Ca** | 940.2 ^a | 976.6 ^a | 94.0 | 97.7 | 78.4 | 81.4 | 94.0 | 97.7 | 78.4 | 81.4 |
| Cu | 0.7 ^{bx} | 0.8 ^{by} | 73.1 | 88.0 | 73.1 | 88.0 | 73.1 | 88.0 | 73.1 | 88.0 |
| Fe | 14.8 | 16.2 | 184.5 | 201.9 | 184.5 | 201.9 | 82.0 | 89.8 | 184.5 | 201.9 |
| K** | 2,400.9 ^b | 2,443.4 ^b | 51.1 | 52.0 | 51.1 | 52.0 | 51.1 | 52.0 | 51.1 | 52.0 |
| Mg | 193.0 ^b | 198.1 ^b | 46.0 | 47.2 | 46.0 | 47.2 | 60.3 | 61.9 | 60.3 | 61.9 |
| Mn | 1.7 ^{bx} | 2.4 ^{by} | 74.3 | 102.9 | 74.3 | 102.9 | 94.9 | 131.5 | 94.9 | 131.5 |
| Na** | 2591.1 ^c | 2741.2 ^c | 172.7 | 182.7 | 199.3 | 210.9 | 172.7 | 182.7 | 199.3 | 210.9 |
| P | 974.8 | 1,006.8 | 139.3 | 143.8 | 139.3 | 143.8 | 139.3 | 143.8 | 139.3 | 143.8 |
| Zn | 14.0 | 15.3 | 127.1 | 139.4 | 127.1 | 139.4 | 174.7 | 191.6 | 174.7 | 191.6 |
| Se | 0.04 | 0.06 | 80.0 | 103.6 | 80.0 | 103.6 | 80.0 | 103.6 | 80.0 | 103.6 |

*RDA = Recommended Dietary Allowances.

*CS = With complementary snack.

**AI = Adequate Intakes.

^{a,b,c}Indicate significant differences among regular, blend and soft diets, or Regular+CS*, Blend+CS* and Soft + CS*.

^{x,y}Stand for significant differences in a mineral supply between the diet with and without complementary snack.

Inadequate nutrition has a strong influence on the health of an individual. It is estimated that 20 to 60% of diseases result from the insufficient intake of nutrients.²⁶ The intake of nutrients by the North-American population has been reported insufficient, specifically with regard to Ca, Mg and K.¹⁶ A study carried out in Slovenia evaluated the amount of minerals in the food served at 51 institutions for the elderly. The concentrations of Ca, Mg, Mn, Cu, Cr, Zn, Se, and I were at least 40% below the RDA.¹⁸ The hospital diets in the

present study also presented a deficit in the supply of minerals, mainly Ca, Mg and K, and an excessive amount of Na.

The supply of Ca was insufficient in all the diets studied (table IV), with the lowest level in the regular diet (504 mg) followed by the blend diet (645 mg). The highest amount of Ca in the soft diet might be explained by the fact that milk is the main food component in this diet. In France, researchers estimated that the mean supply provided by the three main meals

Table V
Average daily value of minerals carried by the regular soft and pasty diets

| Mineral | Regular diet (mg/day) | Blend diet (mg/day) | Soft diet (mg/day) |
|------------|-----------------------|---------------------|--------------------|
| Calcium | 504.7* | 645.4* | 940.2* |
| Copper | 0.8* | 0.9 | 0.7* |
| Iron | 14.0# | 10.7# | 14.8# |
| Potassium | 2,160.7* | 2,589.3* | 2,400.9* |
| Magnesium | 339.9+ | 211.9* | 193.0* |
| Manganese | 3.5 | 2.9 | 1.7* |
| Sodium | 4,675.6 | 4,187.3 | 2,591.1 |
| Phosphorus | 1,028.8 | 1,197.1 | 974.8 |
| Zinc | 7.8* | 12.2 | 14.0 |
| Selenium | 0.06 | 0.07 | 0.04* |

*Mineral content below the recommended levels for both genders and life stages.

#Mineral content below the recommendation only for adult women.

+Mineral content below the recommendation only for adult and elderly men.

Bold: Mineral contents above UL.

(breakfast, lunch and dinner) was 642 mg for individuals who ate out,¹⁹ while Pokorn et al. (1998) reported a mean value of 600 mg supplied by the total of the daily meals provided at institution for the elderly.¹⁸

Copper was below the RDA in the soft and regular diets, reaching the recommendation when the complementary snack was added (table IV), mainly when it was offered in the afternoon. A study carried out in France estimated the mean intake of copper in 0.93 mg/day,¹⁹ while researchers in Slovenia detected a mean of 0.9 mg/day.¹⁸ In Brazil, a study involving meals for institutionalized elderly reported adequate amounts of Cu in blend and semi-liquid diets, with mean values of 1.45 and 1.51 mg/day, respectively.²⁰

The amount of Fe found in all types of diets was insufficient for adult women due to their increased requirements in that life stage. Since among hospitalized patients iron deficiency anemia ranges between 27 and 41%,²¹⁻²³ this situation can be further aggravated by offering iron deficient meals. In France, researchers have detected a mean daily supply of 12.3 mg of Fe in the regular diet,¹⁹ a value even lower than that detected in the soft and blend diets. Researchers found a mean daily supply of 16 mg of Fe in the soft diet served to institutionalized elderly in Brazil.²⁰

Potassium was below the RDA in all the diets studied, the highest level being found in lunch, followed by dinner and the snack (table II). In Brazil, study reported maximum levels of the mineral on days in which the meals include dinner soups, reaching 2,500 mg of K, still below the recommended value.²⁰ Noel et al. (2003) in turn estimated the mean supply of K in 3,640 mg/day, which neither did not meet the recommendation either.¹⁹

Magnesium also fell short of the recommendations in the three meals studied, with lunch having the highest concentration (table II). Noel et al. (2003) and Pokorn et al. (1998) estimated the mean daily intake of

Mg in 192 and 200 mg/day, respectively, both values lower than the nutritional recommendations.^{18,19} Passos and Ferreira (2010) reported a daily supply of 376 mg of Mg in the semi-liquid diet, insufficient to meet the RDA standard.²⁰

The amount of Mn was insufficient only in the soft diet for both genders, reaching adequacy when a snack was added (table IV). The additional afternoon snack provided significantly higher amounts of Mn than the same snack given in the morning (table III). Lunch and dinner were the greatest sources of Mn (table II), in agreement with results other studies.^{18,19}

Zinc was below the recommended levels for adults only in the regular diet and the addition of a complementary snack raised the level to adequacy for women (table IV). Lunch and dinner were also the main meals supplying Zn (table II) due to beef they contain.

With regard to Se, only the soft diet supplied insufficient amounts (0.04 mg) if served without the complementary snack, thus alerting to the importance of soft diets being prescribed along with complementary meals (table III). Noel et al. (2003) and Pokorn et al. (1998) have reported in their studies daily means of 0.07 and 0.03 mg of Se, respectively.^{18,19}

Sodium was the only mineral whose levels were above the UL in all the diets, for both genders and age groups. The amount of Na in the regular diet was 203.3% above the UL and 209.7% when associated with complementary snack. Its levels in the blend and soft diets were above the UL in 182 and 111.3%, rates that increased to 188.6 and 192.0% with complementary snack, respectively.

In Brazil, a study in a long term stay institution for the elderly detected a mean daily amount of sodium supplied in blend diets of 3,526 mg,²⁰ while Noel et al. (2003) reported this amount as being 3,420 mg/day.¹⁹

The mineral imbalance involving excessive Na and inadequate levels of K, Ca and Mg favors hypertension,

coronary disease, among other health problems.²⁴⁻²⁶ Considering that the average hospitalization period in Brazil is about six days,²⁷ susceptible patients receiving these diets could unnecessarily worsen their condition.

The doses supplied by the diets represent the total daily supply of nutrients, rather than their actual intake. This limitation was also pointed out by others researchers.¹⁸ In this sense, if the patients do not consume the meals in their entirety, the mineral inadequacies can be correspondingly widened. Only in the case of Na this situation would be inverted.

Finally, the combination of a diet with its complementary snack was found to be a useful means to increase the delivery of the minerals in short supply: Cu and K in the regular diet, Cu, Fe Mn and Zn in the blend diet and Cu and Mn in the soft diet. However, only for Cu in the regular diet, and Mn and Se in the soft diet, the snack is likely to promote the supply from inadequate to adequate, in contrast to Na, which may increase the risk of toxicity even further.

It becomes advisable therefore to adopt judicious mineral balance policies in the preparation of hospital meals including the use of mineral mixes or supplements and a commensurate reduction in the use of common salt, departing from traditional Brazilian cooking habits. With regards to oral diets, the incorporation of modern concepts on functional foods, such as the properties of spices as vehicles of trace minerals and bioactive substances (ex. cinnamon) may also facilitate the implementation of the proposed road to nutritional adequacy in the mineral status of hospitalized patients.

Considering that malnutrition among hospitalized patients constitutes a highly prevalent healthcare problem with very high costs associated²⁸, prescription of nutritional supplementation, replacing the complementary snack, can be helpful to improve nutritional status^{29,30} or prevents malnutrition in those patients who do not meet their nutritional needs with an oral diet.³⁰

Conclusions

Upon evaluation of the mineral contents of the three oral diets offered to patients at an important hospital of a large Brazilian metropolis the authors find that at present it is not possible to ignore the health risks that patients are exposed to due to the lack of some basic training on diet formulation. Diets other than the regular diet, designed to meet special characteristics seem to bear a higher chances of imbalance. While the blend diet offered the best supply of minerals, but deficiencies in Ca, K and Mg, the soft diet carried the greatest number minerals below the RDA (Ca, Cu, K, Mg, Mn and Se) for both genders and age groups. Fe was below RDA for adult women in all diets, and sodium was the only mineral that exceeded the UL. Serving any oral diet with its complementary snack increased the risk of toxicity further. The combined use of diet and complementary snack, however, could be effective to increase

the amounts of lacking minerals; Cu in the regular, Zn in the blend, and Mn in the soft diet. However, only for Cu in the regular and Mn and Se in the soft diet, the snack made the supply of inadequate minerals meet the RDAs. The inclusion in the menu of foods that are source of the detected insufficient minerals might lead to remedy the levels of those minerals in such a way that it would contribute to improve the nutritional status of the patients.

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