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Chemical evaluation of macronutrients and minerals from handmade enteral diets used in homecare nutritional therapy in the brazilian national health system

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Abstract

Objective: This study aimed to evaluate the chemical composition of nutrients and minerals from homemade enteral diets prescribed in enteral homecare. *Methods*: Data sheets from standard diets with and without lactose prescribed at discharge from public hospitals and by the Support Center for Family Health were collected. After preparation of diets and evaluation of viscosity, stability, odor, color and cost, five diets were selected and grouped according to similarities in the composition in Group A and Group B. They were sent for chemical analysis of nutrients and minerals. The results were compared with the nutritional requirements proposed by the Dietary Recommendations Reference to men aged 51-70 years. *Results and discussion*: The analysis showed diets with a normal distribution of protein lipids and carbohydrates. The total amount of dietary fiber in the diet Group A was between 12 g and 15 g with 48% of soluble fiber. In Group B dietary fiber was 3.40 g and in the standard diet without lactose between 6 and 8 g, with 65% of soluble fiber. Concerning minerals, all formulations were appropriate in iron and most of them in calcium, zinc, phosphorus, copper and sodium. No formulation evaluated presented appropriate values of potassium and magnesium. We observed low adequacy of many minerals in the formulations of 1.200 Kcal. *Conclusion*: The formulations analyzed have adequate macronutrients, but require adjustments in fiber. Minerals in reduced amounts need to be supplemented while dietary adjustments are not made.

Key words: Food Security and Nutrition. Homecare. Enteral Nutrition. Macronutrients. Chemical Composition. Health System. Adults.

Introduction

The expansion of home care for people who need regular or intensive care but not hospitalization, is one of the strategies included in the Ministry of Health's Plan of Action to Combat Chronic Noncommunicable Diseases (NCDs),[1] aiming at comprehensive care and health promotion. Thus, home enteral nutritional therapy (ENT) has been increasingly recommended, for being a feasible and advantageous option, which allows for patient-family interaction, besides assuring more comfort and better quality of life,[2,3] contributing to guarantee the right to adequate and healthy food for those that have special dietary needs.[4-6]

According to the National Health Surveillance Agency (ANVISA), enteral nutrition refers to every food for special purposes formulated and designed for use in catheters or orally, whether industrialized or not.[7] In Brazil, the use of handmade and / or semi-handmade diets is encouraged to individuals under home care.[8]

Handmade or semi-handmade formulas consist of perishable food and / or food products, and also of nutritional supplements.[7] They are cheaper and improve the socio-cultural identity of the food offered, helping to demystify that enteral feeding is artificial[9] and to acknowledge their existence in the scenario of consumption habits.[10] However, they present some disadvantages, such as lack of standardized handmade measures, and their components often require excessive dilution to achieve acceptable viscosity. Time and preparation of cooking may also affect the nutritional composition of diet.[11,12]

In the literature, there are only a few studies that propose low cost fully nutritional handmade enteral diets with proper balance and osmolality. Most available studies on the chemical composition of handmade enteral diets use chemical composition tables, without taking into account food processing losses,[13] with few bromatological analysis and experimental initiatives that accurately quantify macro and micronutrients. Recently, the structuring of some appropriate proposals for macronutrients, but studies on micronutrients are still rare, due to difficulties found with the analytical methods and their cost.[12,14,15]

Therefore, it becomes strategic and essential to develop analytical and experimental studies on food matrix, to support and guide dietary practices in a way to precisely and accurately determine the composition of handmade diets, both for macronutrients and minerals. That way it will be

possible to provide further data on a low cost and nutritionally adequate enteral diet that can easily be prepared, to reduce handmade measure errors as well as errors of preparation protocols arising from dietary techniques.

Under such perspective, this study aims at assessing the chemical composition of macronutrients and minerals from handmade diets prescribed at discharge in well-known hospitals located in the state of Minas Gerais, Brazil, to enable the creation of an analytical reference for the correct enteral handling and management of nutrients.

Materials and methods

Standard and lactose free handmade enteral diet datasheets, prescribed at discharge by eight public hospitals located in Belo Horizonte-MG and by the Support Center for Family Health (Núcleo de Apoio à Saúde da Família - NASF) from the Municipal Health Secretariat, were collected from the nutritionists in charge of releasing prescriptions. Normocaloric and normal protein diet was considered as standard, with no restriction of nutrients, except for lactose in lactose-free formulations.

All handmade or service standardized measures were equalized and converted to mass measures, allowing for the correct transposition of the reported data. After that, diets were prepared in a Technical Dietetic Lab and assessed for viscosity, stability, odor, color, and cost; only diets approved in all of these criteria were included in this study.

The viscosity test was carried out by administering diets through 12-gauge nasogastric and nasoenteral catheters for adults, using the gravitational method with the aid of a equipment for the catheter and in *bolus* using a 20 ml syringe. Suitable viscosity was considered when the administration of diets by both methods occurred without clogging the catheter. The stability of diets was tested by visually inspecting the phase separation process in a 12 hour period of cold storage. Odor and color were assessed through olfactory and visual inspection. All samples had pleasant odor and color. Maximum daily values of R$12 were considered as acceptable expense, or half the value of the Brazilian minimum wage per month in daily offers of 1,800 kilocalories.

After these analyzes, datasheets from five locations were approved. All other datasheets were excluded from this study for presenting high expenses (n = 1) or improper viscosity (n = 3). Thus, standard and lactose free formulations were included in this study (Charts 1 and 2), each with two calorie levels most commonly used in clinical practice, according to information gathered from the nutrition departments of the selected locations.

Three institutions, named Group A, used the same standard diet, and formulations 1,800 and 2,100 kilocalories (kcal) were included in this present work. The other two institutions, called Group B, used similar diets, but besides using the standard diet, they also prescribed the lactose-free diet. In this study, we analyzed the standard formulations of 1,200 and 2,100 Kcal, and lactose-free formulations of 1,200 and 1800 Kcal (Charts 1 and 2). Lack of standardization of the caloric value between groups occurred due to differences found in the nutritionists' prescriptions. The 100 ml samples were submitted for chemical analysis, as described below.

Chart 1. Formulations and characteristics of handmade standard enteral diets, prescribed at discharge in two public hospitals and the Support Center for Family Health (NASF) of the Secretariat of Municipal Health, Belo Horizonte, March 2014.

Food	Standard 1,800Kcal	Standard 2,100Kcal
Whole Milk (ml)	500.00	500.00
Nonfat Milk (ml)	500.00	500.00
Albumin Powder (g)	11.60	29.00 23.20 (2x/week)
Toasted Flour (g)	117.00	117.00
Baked Potato (g)	280.00	280.00
Brazil Nut (g)	2.00	2.00
Soybean Oil (g)	39.00	52.00

Corn-Based Commercial Cereal (g) *	15.00	20.00
Sugar (g)	27.60	27.50
Iodized Salt (g)	2.00	4.00
Cooked Egg (g)	45.00 (2x/week)	45.00 (2x/week)
Maltodextrin (g)	----	-----
Juice (250ml)		
Raw Carrot (g)	55.00	55.00
Orange Juice (ml)	180.00	180.00
Sugar	13.80	27.50
Maltodextrin	----	----
Final Volume without Juice (ml)	**1625**	**1900**
Final Volume with Juice (ml)	**1875**	**2150**
Distribution	**5X325ml + juice**	**5x380ml + juice**
Cost per day (R$) **	**5.57**	**6.68**

*Ingredients commercial cereal-based fortified Corn: Corn flour, sugar, enriched with iron, phosphorus, calcium, zinc, folic acid, niacin, vitamin A, D, E, C, B1 and B6.

** Quotation held in March 2014, in the retail trade in Belo Horizonte.

Chart 2. Formulations and characteristics of handmade standard enteral diets and lactose-free standard, prescribed at discharges in two public hospitals. Belo Horizonte, March 2014.

Food	Standard 1,200 Kcal	Standard 2,100 Kcal	Lactose-free 1,200Kcal	Lactose-free 1,800Kcal
Dry Whole Milk (g)	110.0	195.0	----	----
Food supplement based on enriched soybean extract (g) *	105.0	180.0	----	----
Commercial cereal based on enriched corn (g) **	63.0	117.0	----	----
Iodized Salt (g)	2.0	2.0	2.0	2.0
Soybean Oil (g)	----	----	5.0	5.0
Dry soy milk (g)	----	----	150.0	215.0
Enriched rice cream (g)	----	----	140.0	140.0
Corn starch (g)	----	----	125.0	100.0
Juice (200ml)				
Orange Juice (ml)	120.0	120.0	120.0	120.0
Raw Carrot (g)	55.0	55.0	55.0	55.0
Final Volume without Juice (ml)	**1,200**	**1,800**	**1,200**	**1,800**
Final Volume with Juice (ml)	**1400**	**2000**	**1400**	**2000**
Distribution	**6x200ml + juice**	**6x300ml + juice**	**6x200ml + juice**	**6x300ml + juice**
Daily cost (R$) * **	**5.96**	**10.05**	**10.47**	**12.92**

* Ingredients of food supplement based on enriched soy extract: sugar, soy extract, rice flour, whey, maltodextrin, refined salt, soybean oil, enriched with vitamins C and B1, B2, B6, A and niacin.

** Ingredients of commercial cereal based on enriched corn: corn flour, sugar, enriched with iron, phosphorus, calcium, zinc, folic acid, niacin, vitamin A, D, E, C, B1 and B6.

*** Quote held in March 2014, in the retail trade in Belo Horizonte.

Both macronutrients and micronutrients were analyzed in triplicates. Standard methods recommended by the Association of Analytical Chemists (AOAC)[16] were adopted. Proteína was quantified through the Semimicro-Kjeldahl Method, where the conversion of total nitrogen into crude protein was made by factor 6.25.[16] Total lypids were estimated according with the procedure described by Bligh & Dyer[17] (homogenizer, AP-22, Tecnal®, Piracicaba, Brazil). The soluble and insoluble dietary fiber, by the enzymatic method[18] (metabolic bath with reciprocating agitation, Dubnoff, MA-093, Marconi ®, Piracicaba, Brazil), and ash content by the method of incineration in a muffle furnace (EDGCON 1P, EDG Equipamentos®, São Paulo, Brazil) at 550°C and moisture, complete samples, in oven (M-315 SE, Fanem®, São Paulo, Brazil) 105°C, until constant weight. Total carbohydrates were estimated by subtracting from 100 the sum of protein, lipid, ash, moisture and soluble and insoluble dietary fiber.[16] Results were expressed in g/100 g diet.

The metabolizable energy was calculated using the conversion factors of 4 kcal for carbohydrate and protein and 9 kcal for lipids. Zinc (Zn), iron (Fe), copper (Cu), calcium (Ca), phosphorus (P), potassium (K), magnesium (Mg), manganese (Mn) and selenium (Se) were also quantified in ICP-OES equipment, Varian (ICP-OES 720, Varian Inc., California, U.S.) with the following experimental conditions: Power: 1.20 KW, Plasma flow: 15.0 L / min, Auxiliary gas flow: 1:50 L / min, Nebulizer pressure: 200 kPa, respectively using the following spectral lines: 206.2 nm, 238.2 nm, 327.4 nm, 317.9 nm, 213.6 nm, 766.4 nm, 285.2 and 257.6. Analytical spectral lines were chosen according to sensitivity level of interference. Linear concentration intervals for each element ranged from their limit of detection and the maximum concentration values recommended by the manufacturer's manual. The detection limits (3 x the standard deviation of 10 measurements of the analytical blank divided by the slope of the calibration curve) were determined for all elements read.

To read samples of selenium (Se), a system for generating hydride ($NaBH_4$) was used, mounted on a V-groove platform with a Babington nebulizer, with a 70 mm gas orifice coupled. Stock solutions of 1000 $\mu g.mL^{-1}$ (Spex Sample Preparation, Metuchen, NJ) of elements were used to prepare calibration curves and optimization of analytical conditions. All standards were prepared in the same manner as that of samples. Se (VI) was reduced to (IV) in HCl 4 M, by heating the solution to 90 ° C for 30 min. All aqueous solutions, including dilutions for

diet sample reading, were prepared with ultrapure water (18 MΩ cm^{-1}), Milli-Q (Millipore, Bedford, MA). Certified reference material – NIST - Total Diet SRM 1548 (National Institute of Standards Technology – Gaithersburg, MD) was given to validate the analytical measurements in ICP-OES spectrometer.

After analysis, results found were compared with the proposed nutritional needs by Reference Dietary Recommendations (DRIs) for healthy men considering the age group of 51-70 years.[19,20] This age group and gender have been chosen because most patients using TNE at home are older than 50, and the recommendations of minerals for males are greater than for females, thus covering the needs of both, except for calcium. The adequacy of iron, copper, zinc, calcium, phosphorus, magnesium and selenium was made by comparing the value found in the analysis with the Recommended Dietary Allowances (RDA) and Maximum Tolerable Intake Level (UL) considering appropriate offer the values between the RDA and UL. Sodium, potassium and manganese, which have no established RDA, were evaluated for Adequate Intake (AI) and UL.[19,20] Additionally, sodium and potassium were analyzed for their relationship (sodium / potassium) , with focus on blood pressure control and cardiovascular health, considering appropriate values from 0.49 to 0.32.[19, 21]

Although this study did not focus on the microbiological quality of the diets, they were prepared considering criteria for safe handling. The same care is geared to caregivers of patients at hospital discharge and are checked *in situ* by nutritionists of NASF in home visits.

All participating hospitals, as well as NASF, are partners in the project in which this study is inserted and have signed a consent agreement make handmade enteral formulas for diets in hospital discharge available for chemical analysis and dissemination of blind results.

Results

Centesimal composition data, wet basis (Table 1), show that the distribution of macronutrients, proteins, carbohydrates and lipids in relation to calories was approximately 14.0%, 50.0% and 36.0% in standard formulations of Group A; and 16.5%, 49.0% and 34.5% in the standard formulations of Group B, respectively. Lactose-free formulations were distributed to proteins, carbohydrates and lipids at approximately 17.0%, 56.0% and 27.0%.

Regarding moisture (Table 1), the mean value for diets of both groups was 78%, excluding the juice. Values below 80% are considered low, and as found in the analyzes of this study, suggest the large amount of solutes used for the formulation of all diets exposed, regardless of their group.

Total amount of dietary fiber in the diets of Group A was 11.86 g for the standard 1,800 kcal, and 15.46 g for the standard 2100 kcal, with 48% soluble fiber in both. This does not occur in standard diets of Group B, whose intake of dietary fiber is exclusively due to the juice, being 3.40 g for both caloric standards. In the lactose-free formulation, content is a little higher, with 6.04 and 8.44 g for the diets of 1,200 and 1,800 kcal, respectively, with approximately 65% soluble fiber.

With regard to the total caloric content of diets analyzed (diet + juice), Group A have total calorie compatible with the planned caloric levels calculated using data from food centesimal composition tables, not exceeding more than 5.5% of the desired caloric goal. This same analytical behavior can be noted in the standard 1,200 Kcal diet and in the lactose-free standard diets of Group B, showing that, despite differences in composition and primary source of nutrients between the diets of these groups, all of them properly meet the demand for macronutrients to which they were proposed. However, the standard diet of 2,100 kcal of Group B presents 2,417 Kcal, or 15% above the planned level.

Table 1. Centesimal composition (% wet basis) of the handmade enteral formulations prescribed at discharge in four different public hospitals and Support Center for Family Health (NASF) from the Secretariat of Municipal Health. Belo Horizonte, March 2014.

	FORMULATIONS							
	Group A			Group B				
	Standard 1,800 Kcal	Standard 2,100 Kcal	Juice	Standard 1,200 Kcal	Standard 2,100 Kcal	LF* 1,200 Kcal	LF 1,800 Kcal	Juice
Moisture	77.99	77.32	81.47	80.38	77.03	78.81	78.06	86.05
Crude Protein (N x 6.25)	3.67	3.71	1.27	3.95	4.53	4.03	4.28	1.11
Total Lipids	4.31	4.34	0.15	3.75	4.23	2.90	3.09	0.13
Carbohydrates	13.08	13.52	14.55	11.46	13.59	13.51	13.75	10.59
Soluble Dietary Fiber	0.12	0.16	1.50	0.00	0.00	0.12	0.16	1.29
Insoluble Dietary Fiber	0.29	0.38	0.58	0.00	0.00	0.10	0.12	0.41
Total Dietary Fiber	0.41	0.54	2.08	0.00	0.00	0.22	0.28	1.70
Ashes	0.54	0.58	0.48	0.46	0.62	0.53	0.54	0.42
Calories (Kcal)	105.79	107.98	64.63	95.39	110.55	96.26	100.01	47.97

*LF = Lactose Free

Table 2 shows mean values and respective standard deviation of the minerals analyzed. It is overall observed that the amount of iron, copper, zinc and calcium is higher in Group B. Further potassium and selenium intakes are observed in the formulations of Group A. However, potassium is below Al, and its relationship with sodium is also inadequate in all formulations. Lactose-free

standard diets probably present manganese deficiency. No formulation analyzed is considered adequate for magnesium. Sodium is below AI only on lactose-free standard diets, and above the UL in the standard diet of 2,100 kcal of Group A.

Table 2. Mineral concentrations of the handmade enteral formulations prescribed at discharge in four different public hospitals and Support Center for Family Health (NASF) from the Secretariat of Municipal Health. Belo Horizonte, March 2014.

	FORMULATIONS					
	Group A Mean (SD)		Group B Mean (SD)			
	Standard 1,800 Kcal	Standard 2,100 Kcal	Standard 1,200 Kcal	Standard 2,100 Kcal	LF* 1,200 Kcal	LF 1,800 Kcal
Iron (mg)	7.92 (0.77)	8.88 (0.50)	26.28 (1.68)	35.08 (1.93)	27.11 (2.42)	36.40 (2.28)
Copper (mg)	3.01 (0.19)	5.76 (0.37)	6.80 (0.44)	9.73 (0.,58)	14.01 (1.13)	16.22 (1.37)
Zinc (mg)	9.74 (1.37)	10.92 (0.92)	17.31 (1.26)	21.95 (1.73)	22.59 (2.76)	25.12 (2.01)
Calcium (mg)	1,116.59 (88.21)	1,161.63 (96.13)	2,285.02 (106.92)	2,992.79 (174.85)	1,283.66 (95.74)	1,927.84 (108.14)
Phosphorus (mg)	976.74 (59.16)	1,137.81 (74.18)	1,174.93 (95.41)	1,942.94 (112.15)	509.70 (27.19)	578.12 (25.85)
Potassium (mg)	2,199.26 (100.38)	2,202.45 (118.44)	1,581.66 (133.02)	1,962.37 (125.98)	507.03 (29.06)	726.69 (33.08)
Magnesium (mg)	260.31 (13.54)	277.40 (17.14)	146.46 (8.19)	214.18 (12.90)	139.50 (13.63)	169.46 (12.03)
Manganese (mg)	2.14 (0.09)	3.44 (0.18)	2.31 (0.18)	2.94 (0.32)	1.51 (0.17)	2.18 (0.15)
Selenium (μg)	127.60 (11.45)	131.52 (10.63)	12.05 (0.89)	13.80 (1.07)	12.66 (1.45)	14.04 (1.33)
Sodium (mg)	1,751.17 (102.89)	2,557.91 (136.79)	1,927.36 (171.07)	2,240.52 (185.29)	1,191.89 (129.94)	1,503.24 (121.81)

*LF= Lactose Free

Discussion

Diets analyzed in both groups showed normocaloric, normoprotidic, and normolipidic nutritional composition. In recent work, Santos et al.[12] found similar results when assessing the macronutrient distribution of handmade enteral diets prescribed at home. Carbohydrates were the only exception, their value was greater (16.9 g carbohydrates in 100 g diet) than that found in the analyzes of this study (on average 13 g of carbohydrate per 100 g diet). This may occur due to differences in the carbohydrate source used in the diets.

Those analyzed by Santos et al.[12] have maltodextrin as main source, while Group A contain wheat flour, potatoes and sugar as main source of carbohydrates, and Group B have food complement based on soybean extract enriched with vitamins and minerals and commercial cereal based on corn, fortified with vitamins and minerals as source of carbohydrate for the standard diet, and corn starch and rice cream for the lactose-free standard diet.

Sucrose is present on diets, an ingredient that is acceptable in a standard diet. Besides sugar, commercial cereal and soy supplement they contain, respectively, 20% and 25% of the total calories consisting of sucrose (information provided by the manufacturers). This results in 5.6% and 8.4% of the total calories from sucrose to the standard diets of groups A and B respectively, amounts considered acceptable.[19] Standard lactose-free diets have no sucrose in their formulation.

The protein intake of diets examined is considered to be appropriate considering the percentages established in the DRIs for adult men aged 51-70 years.[19] However, it is important to note that when this value is converted to grams per kilogram of body weight , the values of the diets of 1,200 kcal in group B (0.70 and 0.72 grams of protein per kg of body weight, assuming a 70 kg adult) are below the recommended by the Nutritional Recommendations for Adults in Enteral and Parenteral Nutrition Therapy.[22] This finding is important, since protein is an essential nutrient involved in wound healing and immunological function.[23] In addition, Homecare Enteral Nutrition Therapy assists a varied profile of patients, usually adults or the elderly, who are usually carriers of diseases that increase caloric demand and which can occur with some form of malnutrition.[24] Thus, adequate protein intake should always be prioritized in the formulation of handmade enteral diets.

Although the percentage contribution of calories from lipids in both groups is appropriate,[19] the fatty acid profile of these diets, calculated through a food chemical composition table (data not shown), do not fully meet recommendations.[19] Diets of Group A had lower levels of monounsaturated and saturated intermediate fatty acids; whereas Group B showed diets high in saturated and

very low monounsaturated fatty acids. The literature well establishes the protective effects of monounsaturated and polyunsaturated fatty acids on cardiovascular health and, conversely, the deleterious effects of saturated fatty acids.[25]

The ingredients of the original diets include canola oil (diet of Group A) or olive oil (diet of Group B). However, nutrition services prescribing such diets have changed this formulation to 100% soybean oil, after a cost-benefit analysis and the finding that this modification would not bring significant impact on the fatty acid profile, taking into account the good fatty acid ratio of n-6 and n-9 presented by soybean oil. It is noteworthy that, in the diets of Group A, the substitution of 50% vegetable oil in the formula by canola oil increased the proportion of monounsaturated fatty acid, with a monthly cost impact of 3.30 dollars. The introduction of virgin olive oil in lactose-free standard diets in Group B increased cost by 3.20 dollars per month. The standard diet of Group B does not have vegetable oil in its composition, and the lipid comes from whole powder milk and food-based soy extract supplement - hence the appropriateness of the fatty acid profile should consider deeper changes in the formulation.

The amount of dietary fiber in the diets of Group A was 50% below the recommended range for men 51-70 years old,[19] whereas in the diets of Group B, even smaller percentages of adequacy were found (30% of average adequacy). It is important to mention the high percentage of soluble fiber, around 48% in the diets of Group A and 65% in Group B. The fiber content found in the standard diet of 2,100 kcal in Group A is greater than that of other studies, and similar in the remaining formulations.[15,26,27] A fact that has probably contributed to the fiber content of diets analyzed has been their manner of preparation, in which only the juice was sieved, besides the fresh characteristic of the ingredients in the formulations of group A.

Fiber plays an important role in the body, since it is involved with proper bowel function. Moreover, soluble fiber is fermented to produce short chain fatty acids involved in intestinal tropism and in the maintenance of healthy microbiota.[28,29] However, adequacy of dietary fibers in handmade enteral diets is a known issue, as it directly affects the viscosity and fluidity of diet.[30] Another drawback is gastrointestinal intolerance, which may cause side effects like flatulence, bloating or changes in the consistency of feces[28,31] and, in the case of insoluble fiber, the possibility of reducing the bioavailability of minerals such as calcium and iron.[32] Recently, Araujo et al.[27] have proposed the use of freeze-dried food in handmade enteral diets, to reach a better adequacy of dietary fibers. Cinnamon at 25g / 2,000 ml in formula was the food that contributed the most to increased total fiber.[27]

The percentage of moisture found was 76% for all diets analyzed, which is low compared to other types of handmade enteral formulations (values above 85%).[33] This indicates a large amount of solutes used for the formulation of all diets in this study, regardless of their group.

Regarding minerals, they showed significant difference between Groups A and B. Such difference can be due to the greater supply of industrial products in the diet of Group B, which also resulted in higher expense. All formulations had appropriate iron and, most of them, calcium, zinc, phosphorus, copper and sodium. No formulation examined found appropriate values of potassium and magnesium. Poor adequacy of many minerals was noted in the formulations of 1,200 Kcal, which should be assessed carefully when prescribing caloric patterns that are this low.

These findings are partially distinct from Von Atzingen et al., who found inadequate concentrations of iron, copper, magnesium and calcium in handmade enteral diets based on meat protein hydrolyzate.[15] Minerals are used as cofactors by several enzymes in many cellular functions, and are important to the body's metabolism, in addition to being an antioxidant and playing a role in the immune system.[34]

Iron concentrations found in the analyzes were very close to that recommended for Group A, while in Group B, they were close to that of UL. This same pattern was also noted for zinc. These are important minerals, because they are involved in the metabolism of erythrocytes, and zinc is directly involved in cell replication and proliferation of fibroblasts.[35]

Diets of Group A and lactose-free diet of Group B showed acceptable calcium levels.[20] However, the standard 2100 kcal diet of Group B exceeded the maximum tolerated recommendation, which is 2,500mg.[20] Bedridden individuals, a common condition among TNED patients, show rapid bone loss,[36] which increases the risk of kidney stones because of increased excretion of urine calcium.[37] Furthermore, high intake of dietary calcium may reduce the absorption of magnesium.[19] Thus, calcium supply should not exceed maximum tolerable recommendation.

Phosphorus is deficient only in lactose-free diets in Group B. Although dysfunction is rare and the bioavailability of this mineral is high,[32] low plasma levels harm bone health and muscle strength, and increase the weakness of patient.[19]

Magnesium was below RDA values for all analyzed diets; however, the literature describes that magnesium intake tends to be lower than recommended in diets even orally. Several factors are involved in decreased supply of magnesium, such as loss during the cooking process and during the refining of foods. Magnesium is an important intracellular mineral for physiological processes, including neuromuscular function and maintenance of cardiovascular tone.[38] Thus, proposals for inclusion of foods rich in magnesium such as dark green or even dehydrated vegetables should be assessed and implemented.

The presence of two grams of Brazil nuts in the formulations of Group A was responsible for the adequacy of selenium, which was not found in the formulations of Group B. It is known that selenium is incorporated in selenoproteins, playing an important role as antioxidant and anti-inflammatory. Low levels of selenium have been associated with increased risk of mortality, impaired immune function and cognitive decline.[39]

Sodium is a mineral that has extensive scientific literature with strong evidence linking low consumption to lower systolic and diastolic blood pressure in normotensive and hypertensive.[40,41] However, there is not a determined exact recommendation. While nutrient recommendation guides suggest a consumption of 1200-2300 mg / day to prevent and control arterial pressure,[19] studies demonstrate low impact on cardiovascular mortality and morbidity in diets below 2300 mg,[40] suggesting a consumption of 3,000 mg / day for the general population.[41] On the other hand, the elderly, who represent the largest target audience of the diets in this present study, are, from the standpoint of electrolyte homeostasis, more responsive to sodium reduction in the diet.[40]

Another aspect to be considered is the relationship between sodium and potassium.[42] Studies show that a high Na / K ratio is independently associated with increased risk of cardiovascular disease and all-cause mortality,[43] pointing to the dietary recommendations of a Na / K ratio of 0.49.[21] Thus, the formulations analyzed are considered appropriate in sodium, except for the standard diet of 2,100 in Group A, but no formulation has adequate Na / K ratio, and the minimum value found in the standard diet of 1,800 kcal in Group A (0.80) and the maximum value in the lactose-free diet of 1.200Kcal in Group B (2.35).

Copper showed very low values in the diets of Group A. Despite the low prevalence of copper deficiency, it is related with normocytic and hypochromic anemia, leukopenia and neutroponia in adults.[19]

Conclusion

Data described in this work allowed an unprecedented analysis of the centesimal and mineral composition of handmade diets employed at discharge in four well-known hospitals in the National Health System in Belo Horizonte and the Primary Care of the city. It was possible to conclude that the distribution of macronutrients, in general, has proved to be correct, requiring caloric adequacy only for one of the formulations studied. Dietary fiber has been found in low concentrations in all diets examined, and it must be targeted for modification to provide a better profile of such nutrient, both in soluble and insoluble components.

In the analysis of minerals, it was possible to verify the need for adequacy by supplementation of magnesium and potassium in all diets studied, while dietary adjustments are not made. This same recommendation is valid for copper in the diets of Group A. Calcium and sodium need to be reduced in two diets studied, through changes in dietary components.

Despite the specificity of the correction of minerals, it was observed that the inclusion of diverse food matrices, such as nuts and oilseeds, which can be easily transformed into powder and dissolved, can constitute a route for supply of micronutrients without significant increase in expenses. Strategies such as that, which make part of the exercise of dietary technique, contribute to the improvement of the profile of nutrient supply through the home enteral method, making patient diet become similar to the food their families eat.

Upon receiving the data generated in this work, the hospitals and NASF teams have the opportunity to make the necessary adjustments to their diets, generating a positive impact on nutritional care and improving the quality of Home Enteral Nutrition Therapy, based on the precepts of the National Food and Nutrition Policy and provided in the Guidelines of the Unified Health System. All results presented in this manuscript have been transferred tohospitals and NASF involved in the study, who are adjusting their diets and prescriptions.

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