Nutritional Status and Adequacy of Energy and Nutrient Intakes among Heart Failure Patients

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Summary

Summary: **Increased knowledge about nutritional status and energy and nutrient intakes is required to improve the treatment of patients with heart failure (HF).**

Objectives: **To verify the nutritional status and evaluate the adequacy of energy, macronutrient and micronutrient intakes in patients with HF in outpatient clinical settings.**

Methods: **We collected anthropometric and habitual dietary intake data of 125 patients (72% men, 52.1 ± 9.8 years, BMI 26.9 ± 4.4 kg/m2). Anthropometric variables were compared between genders, and the adequacy of energy and nutrient intakes was analyzed according to current recommendations.**

Results: **Muscle depletion or risk of depletion was present in 38.4% of patients (association with male gender, p <0.0001). In 69.6% of cases the mean energy intake was lower than the one required (p <0.0001). Among the micronutrients evaluated in this study, there was an important prevalence of inadequacy in magnesium, zinc, iron and thiamine intakes, and most patients had calcium and potassium intakes below the adequate levels, and sodium intake above the adequate levels.**

Conclusions: **Outpatients with HF showed muscle depletion, and inadequate energy and nutrient intakes. There was no significant association between habitual dietary energy intake and nutritional status. Multidisciplinary care should be encouraged to better assess the general condition of these patients. (Arq Bras Cardiol 2009; 93(5):501-507)**

Key words: **Heart failure; nutritional status; energy intake; nutrients; adequacy.**

Introduction

Heart failure (HF) is a complex and progressive clinical syndrome, which has limited prognosis and often evolves to cardiac cachexia[1,2]. From 2000 to 2007, circulatory system diseases were the third most important cause of hospitalization by the Unified Health System in Brazil, and HF was the most frequent condition, which accounted for more than 2.7 million hospitalizations, corresponding to 29.3% of all cardiovascular diseases and 3.0% of all hospitalizations[3].

The non-pharmacological and non-surgical approaches in the treatment of patients with HF have been very useful to help manage symptoms, reduce the number of readmissions and improve quality of life[4]. Among the factors associated with the development and progression of HF, energy and nutrient intakes and nutritional status of the patients are of major importance[5,6]. However, prior investigations suggested that body mass index (BMI), a parameter routinely used to determine nutritional status, has reduced sensitivity to detect severe malnutrition among patients with heart disease[7].

A more complete understanding of the factors involved in HF may improve the treatment results, minimize complications and ensure greater compliance with therapeutic measures[8]. Therefore, the objectives of this study were to verify the nutritional status and to evaluate the adequacy habitual dietary energy, macronutrient and micronutrient intakes (calcium, phosphorus, magnesium, iron, sodium, potassium, zinc and thiamine) of HF outpatients referred for nutrition care.

Methods

Patients

This was a cross-sectional study involving 125 patients with HF (72% of them men) referred for treatment by a multidisciplinary team. Participants were consecutively seen by the nutrition team of a cardiology institution, from October 1999 to May 2006. The criteria used for the diagnosis of HF were those of the Review of the II Guidelines of the Brazilian Society of Cardiology for the Diagnosis and Treatment of

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Heart Failure[9]. Clinical characteristics of patients are shown in Table 1.

The inclusion criteria included a written consent to participate in the study and complete anthropometric and dietary data regarding the first nutritional consultation. Two patients with incomplete data were excluded, yielding a response rate of 98.4%.

This study is part of a research protocol that has been reviewed and approved by the Ethics Committee for Analysis of Research Projects of the Hospital das Clínicas of the Medical School, University of São Paulo, number 827/99. The patients received information about the project, its objectives, procedures and potential risks, and signed the written informed consent.

Anthropometric assessment

Weight and height were measured on 0.1kg and 0.1cm scales, respectively, for the measurement and diagnosis of the nutritional status of the patients according to BMI, based on WHO guidelines[10]. On the right side of the patients' bodies, the triceps skinfold was measured with an adipometer, and the arm circumference was measured with a non-extensible measuring tape, for the calculation of the arm muscle circumference and the arm muscle area (AMA)[11]. The AMA was corrected according to gender, by subtracting the arm bone area[12]. For the diagnosis of the nutritional status of the patients according to the AMA, we used the values of Frisancho[13].

Evaluation of the estimated energy and nutrient intakes

Trained nutritionists collected qualitative and quantitative data regarding the habitual diet of the participants, using a diet history interview[14]. Self-reported intake of commonly consumed foods and beverages and food preparation practices were systematically assessed, and the amounts were provided in portion sizes. Additionally, the amounts of salt and oil consumed by the patients over a period of one month were estimated to determine with greater accuracy the consumption of these food items. We used the Nutrition Support Program – NUTWIN, version 1.5[15], to calculate the amounts of energy, carbohydrates, proteins, lipids and micronutrients. We quantified calcium, phosphorus, magnesium, iron, sodium, potassium, zinc and thiamine for their relationship with HF[5,6].

Adequacy of the estimated energy and nutrient intakes

For the assessment of habitual dietary energy intake, we used body weight and BMI (biological markers of energy intake-expenditure balance or imbalance) and determined the proportions of low-weight, healthy weight and overweight individuals[10]. The estimated energy intake was compared to the specific energy requirements in patients with HF[16].

In the absence of specific recommendations for consumption of macronutrients and micronutrients for individuals with HF, we used the recommendations proposed by the Food and Nutrition Board (FNB)[17].

For the analysis of macronutrients, we observed the acceptable distribution ranges for adults[17], and we estimated the proportions of individuals on diet classified as adequate, above or below the recommended. In the assessment of the intake of micronutrients, the prevalence of inadequacy was observed when comparing the distribution of nutrient intake in the group with the estimated average requirement (EAR)[18].

Table 1 - **Clinical characteristics of patients with heart failure**

	Total
Age (years)	52.1 ± 9.8
Gender (M/F)	90/35
Functional Class (NYHA)	
1	9 (10.5%)
2	45 (52.3%)
3	22 (25.6%)
4	10 (11.6%)
Etiology	
Chagasic	16 (17.3%)
Hipertensive	24 (25.8%)
Idiopathic	15 (16.1%)
Ischemic	28 (30.2%)
Others*	10 (10.6%)
LVEF† (%)	26.6 ± 11.4%

**Other: alcoholic, congenital, peripartum, or valve; † LVEF: left ventricle ejection fraction; Data on functional class, LVEF and etiology available for 86, 93 and 54 patients respectively.*

Phosphorus, magnesium, iron, zinc and thiamine have EARs, and the prevalence of inadequacy was measured using this formula: $z = (EAR - \text{mean intake}) / \text{standard deviation}$[13]. Mean and standard deviation of intake do not need adjustments according to intrapersonal variability, as the diet history accesses the habitual diet and eliminates this variability because it accesses daily changes[14]. After calculating the value of z, we determined the proportion of participants in a state of inadequacy.

Calcium, potassium and sodium do not have established EARs, so we determined the proportions of patients with intakes above or below the adequate intake (AI) values according to gender and age. Whenever the mean intake of the nutrient exceeds the AI, a low prevalence of inadequacy is expected[18].

Statistical analysis

Age and anthropometric variables were tested for normality and homoscedasticity, and transformed to the logarithmic scale, when these assumptions were rejected. Then, they were compared between genders through the non-paired t test.

The relationships among energy intake, BMI and AMA were analyzed by the construction of dispersion graphs and by Pearson's correlation test. We applied the paired t test and the Wilcoxon signed-rank test to compare the dietary energy intake with the calculated energy requirements. Qualitative variables were compared using the chi-square test. P-values <0.05 were considered significant. The statistical analysis was performed in SPSS software version 13.0 (Statistical Package for Social Science Inc., Chicago, Illinois, USA). The results were presented as mean and standard deviation (SD).

Results

Anthropometric data of patients

Anthropometric data of the patients are shown in Table 2. Age groups did not differ significantly by gender (chi-square = 6.028, p = 0.110). Four individuals (3.2%) had low weight, 35 (28.0%) had healthy weight, 57 (45.6%) had risk of obesity, 25 (20.0%) had grade I obesity, three patients (2.4%) had grade II obesity, and one patient (0.8%) had grade III obesity. There was no association with gender (chi-square = 2.84, p = 0.725).

The AMA assessment showed that 21 patients (16.8%, all men) had muscle depletion and other 27 (21.6%, 22 men) were at risk of depletion. Muscle reserves within the average for age and gender were observed in 58 subjects (46.4%, 41 men), and 19 (15.2%, six men) were above average or in "good nutrition" condition . The AMA classification showed a significant association with gender (chi-square = 28.670, p <0.0001). Table 3 shows the mean values of BMI, according to AMA classification groups.

Adequacy of the estimated energy intake

The Pearson's correlation test showed no significant association between the habitual dietary energy intake and the BMI or the AMA (Figure 1).

The AMA assessment of the nutritional status indicated risk of depletion or depletion of muscle reserves in 38.4% of cases. The mean energy intake among the patients (1545.3 ± 626.9 kcal) was significantly lower than the energy requirements of the group (1817.4 ± 299.8 kcal, p <0.0001), and the Wilcoxon signed-rank test identified 87 individuals (69.6%, and 59 men) with habitual intake below the estimated energy requirement. The remaining 38 participants (31 men) had a habitual intake above the requirement. There was no association between energy intake below or above the requirements and gender (chi-square = 2.485, p = 0.115).

Table 3 - **Mean values of body mass index of patients with heart failure, according to the classification of arm muscle area groups**

	Values of body mass index (kg/m²)					
AMA Classification	n	Mean	SD	Minimum	Maximum
Risk of depletion or depletion	48	24.2	3.2	17.8	31.0
Muscle reserves within average	58	27.9	4.3	18.3	44.0
Above average or "good nutrition"	19	30.4	3.5	24.5	36.7
Total	125	26.9	4.4	17.8	44.0

Data presented as mean, standard deviation, minimum and maximum values.

Adequacy of the estimated macronutrient and micronutrient intakes

Figure 2 shows the proportions of individuals with adequate, above or below the recommended intakes of macronutrients. The average carbohydrate content in the diet was 52.2 ± 9.4%, the average protein content was 20.9 ± 5.9%, and the average lipid content was 26.9 ± 7.9%. There was no association between these ratios and gender.

Probabilities of inadequate intake of phosphorus, magnesium, iron, zinc and thiamine are shown in Table 4. As to magnesium, only two participants were in the age range of 19-30 years. Therefore, the calculation of inadequate intake of this mineral was possible only for patients above 30 years of age. The proportions of subjects with calcium, potassium and sodium intakes above and below the AI are shown in Figure 3.

Discussion

This study observed that the mean BMI of patients provides their classification of risk of obesity, which is consistent with previous results[19,20]. The increase in BMI is known to raise the risk for the development of HF in both genders, regardless of

Table 2 - **Anthropometric data of patients with heart failure**

	Men (n=90)		Women (n=35)		Total (n=125)	
	Mean	SD	Mean	SD	Mean	SD
Age (kg)	75.7*	14.2	63.8*	12.9	72.4	14.8
Height (cm)	167.1*	7.6	155.3*	6.3	163.8	9.0
Body mass index (kg/m²)	27.0	4.3	26.4	4.8	26.9	4.4
Triceps skinfold (mm)	13.8*	6.1	20.5*	8.2	15.7	7.4
Arm circumference (cm)	30.7	3.8	30.7	4.3	30.7	3.9
Arm muscle circumference (cm)	26.4†	3.0	24.3†	3.5	25.8	3.2
Corrected arm muscle area (cm²)	46.0‡	12.9	41.2‡	13.9	44.7	13.3

*Data presented as mean and standard deviation; * Significant difference between men and women (p < 0.0001); † Significant difference between men and women (p = 0.001); ‡ Significant difference between men and women (p = 0.032).*

Tabela 4 - Prevalence of inadequacy of habitual intake of micronutrients in patients with heart failure

	Média	SD	z	p*
Phosphorus (mg)				
Men (EAR* = 580 mg/day)	1030.5	431.8	-1.0	14.7%
Women (EAR* = 580 mg/day)	784.8	289.2	-0.7	24.2%
Total	961.7	411.1	-0.9	17.1%
Magnesium (mg)				
Men > 30 years (EAR* = 350 mg/day)	249.8	103.0	1.0	82.9%
Women > 30 years (EAR* = 265 mg/day)	197.3	76.2	0.7	75.8%
Iron (mg)				
Men (EAR* = 6 mg/day)	14.3	7.2	-1.2	12.5%
Women ≤ 50 years (EAR* = 8.1 mg/day)	9.8	4.1	-0.4	34.5%
Women > 50 years (EAR* = 5 mg/day)	9.4	3.4	-1.2	11.5%
Zinc (mg)				
Men (EAR* = 9.4 mg/day)	11.4	6.8	-0.3	38.2%
Women (EAR* = 6.8 mg/day)	7.4	3.5	-0.2	42.1%
Thiamine (mg)				
Men (EAR* = 1.1 mg/day)	1.4	0.7	-0.5	30.9%
Women (EAR* = 0.9 mg/day)	1.1	0.4	-0.4	36.3%

*Data presented as mean and standard deviation; * EAR - estimated average requirement for groups; † - Estimated prevalence of inadequacy calculated according to available EAR for gender and age.*

other risk factors[21,22], and yet it is also associated with a better prognosis in patients with chronic and acute decompensated HF[20, 23,24], which characterizes the obesity paradox[19,25].

It should be noted that, despite the fact that only 3.2% of patients had low weight, approximately 40% were at risk of depletion or had depletion of muscle reserves. Disproportionate mobilization and deposition of muscle and adipose tissues may occur[26], and it is noteworthy that protein degradation plays an important role in the progression of HF[6,26,27].

The use of BMI alone, which has low sensitivity for predicting severe malnutrition among cardiac patients[7], may not confirm the adequacy of the energy intake in patients with HF. In addition to the considerable proportion of participants with values of AMA indicating risk of depletion or depletion, we observed that almost 70% of patients did not meet the energy requirement with the habitual intake of food. Aquilani et al[26] identified a similar proportion (70.1%) of HF patients (52 men and five women, 52.0 ± 3.0 years) with a negative energy balance, though they had normal total energy expenditure, measured by indirect calorimetry, as reported in a daily food intake log[26]. Recently, Catapano et al[28] observed a dietary energy intake below the required in 72% of HF patients aged over 60 years[28], and Price et al[29] observed the same in 64% of individuals aged 80.8 ± 6.8 years[29]. To complement these results, we found no significant correlation among energy intake, BMI and AMA, which indicates that the nutritional status of patients with HF is influenced by other variables beside energy consumption[6,26,28].

Most patients had an adequate intake of macronutrients[17], in accordance to the recommendations. In the study of Price et al[29], they found that all patients had an adequate intake of protein, in accordance to the recommendations, and more than 60% of them had the recommended intake of lipids[29]. The average carbohydrate and protein contents were higher than those observed by Aquilani et al[26], but both met the parameters established by the FNB[17]. However, a significant proportion of patients had depleted muscle reserves. Therefore, it is

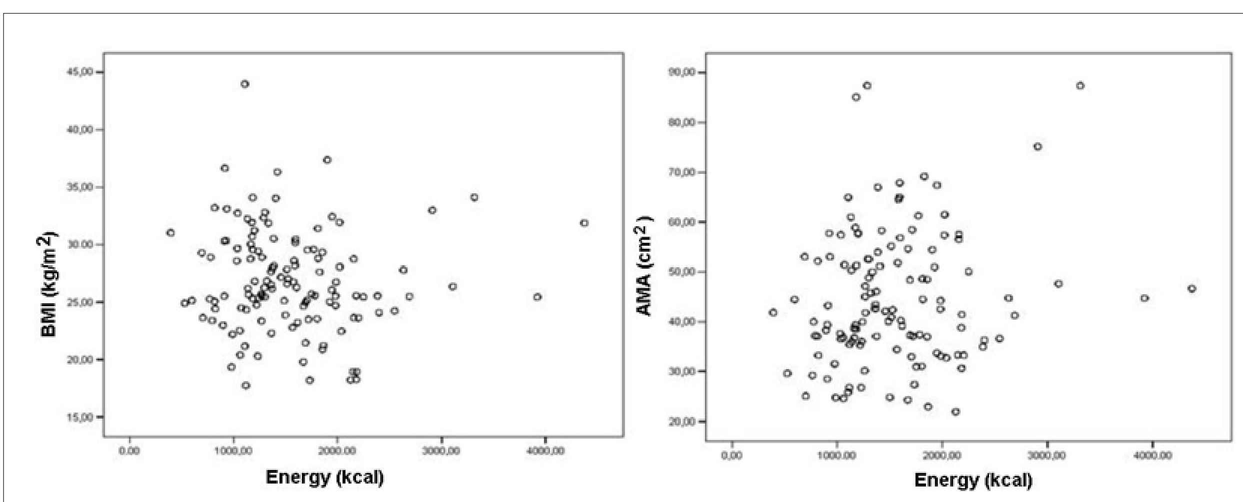

Figure 1 - *Pearson's correlation between dietary energy intake and body mass index and between dietary energy intake and arm muscle area in patients with heart failure; BMI - body mass index; AMA - arm muscle area.*

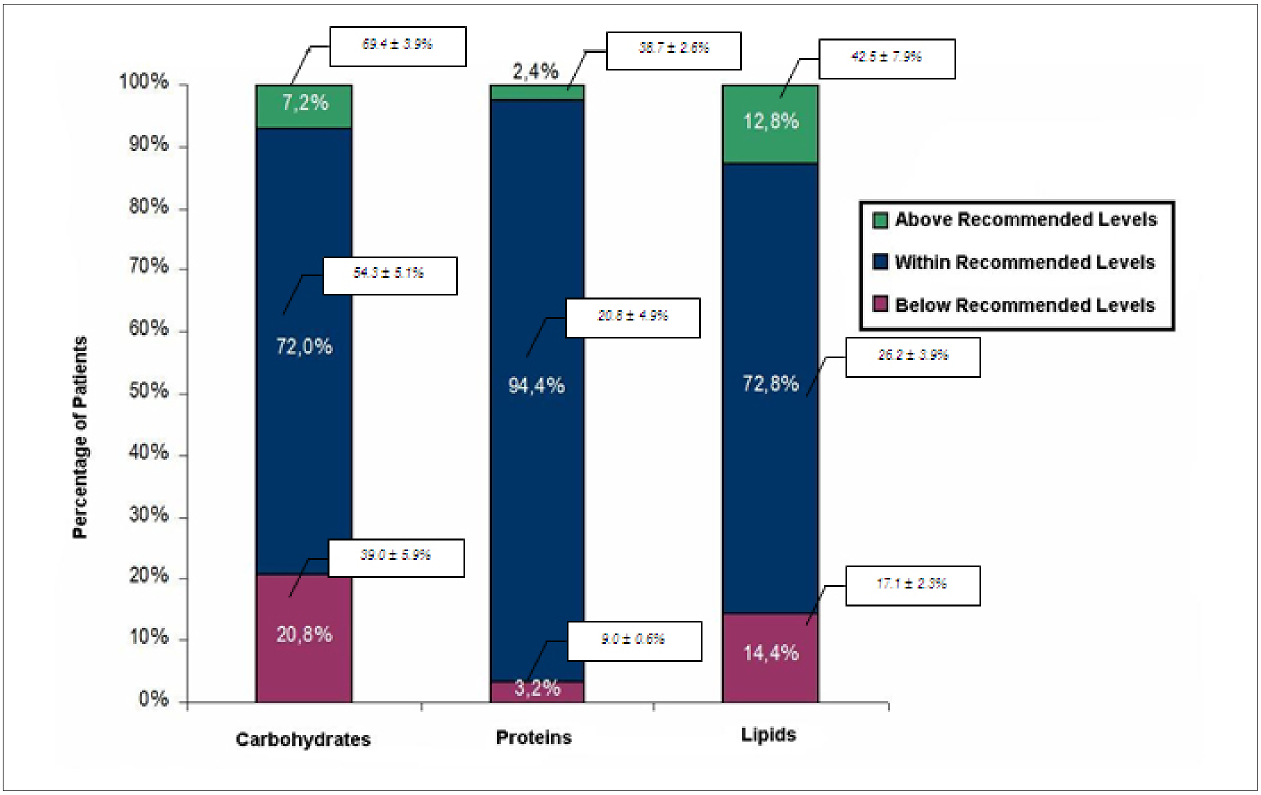

Figure 2 - Percentage of HF patients with macronutrient proportions above, below or within the acceptable distribution ranges. Acceptable distribution range of carbohydrates: 45-65% of dietary energy intake. Acceptable distribution range of proteins: 10-35% of dietary energy intake. Acceptable distribution range of lipids: 20-35% of dietary energy intake. The values in the boxes are expressed as mean and standard deviation of each macronutrient proportions, according to groups of patients who are above, below or within the recommended levels.

noteworthy that the acceptable distribution range of proteins is broad (10-35% of total energy intake)[17] and HF is characterized by catabolism[6]. In addition, Aquilani et al[26] found a negative balance of nitrogen in approximately 60% of their patients, suggesting that the ingestion of normal amounts of protein may not be appropriate for individuals with HF[26].

Among the micronutrients, we observed a low proportion of individuals with inadequate intake of phosphorus, and there are no previous studies showing a direct relationship between HF and the intake of this nutrient, which is abundant in many foods and has a specific relationship with cardiac energy metabolism[30]. Furthermore, there was a high prevalence of inadequate intake of magnesium, which has been reported in patients with HF. The hypomagnesaemia, which usually results in arrhythmia, which is common in these individuals, has a relationship with the aldosteronism that is observed in HF and with worse prognosis, and may be aggravated by the action of diuretics[25,31].

The proportion of individuals with inadequate intake of iron was higher among women aged 50 years, due to their greater iron intake requirement[17]. Iron deficiency can lead to anemia, which has been associated with HF[32]. A multicenter study found that anemia is an independent prognostic factor and it is significantly associated with mortality rate (RR = 3.1)[33]. Regarding zinc, an inadequate intake was observed in approximately 40% of men and women. Reductions in serum concentrations of zinc are associated with the development of HF, and its urinary excretion increases with the use of diuretics. Moreover, zinc has an antioxidant function and its deficiency causes changes in taste and may affect the normal food intake[31]. The consumption of thiamine was inadequate in more than 30% of the group. This vitamin acts as a coenzyme in energy metabolism and its deficiency is detected in patients with HF, particularly in undernourished elderly patients, when in use of diuretics and in more severe forms of the disease[5,25,31,34].

Price et al showed a high proportion of patients with potassium intake below 3,500 mg/day[29], in agreement with these results. It was also noted that almost all patients did not meet the AI for calcium. It was observed that HF patients have deficient dietary intake of calcium and its absorption is impaired by vitamin D deficiency, age and the use of diuretics. The aldosteronism increases the losses, leading to hypocalcemia, osteoporosis and osteopenia, which are common in HF patients[5,25,31].

Thus, the deficiency of several micronutrients may be related to the development and progression of HF. Although there is no consensus established, all these evidences corroborate the need for supplementary feeding for these patients, since the usual food intake may be affected and the loss of nutrients may be increased[5,25,31].

Finally, 84% of patients had sodium intakes above the AI of

1500 mg/day. In the study by Price et al[29], 82% of the patients had sodium intakes above 2000 mg/day, and 44% of them had sodium intakes above 3000 mg/day[29]. Restriction of sodium is a vital component of the treatment of patients with HF, and currently there is no consensus on the maximum intake. It can be said that an intake of 2-3 g sodium meets the recommendations of organizations such as AHA/ACC and HFSA[25], and that these values exceed the proposed AI[17]. It is well established that an excessive consumption of sodium exacerbates the symptoms of HF, increasing fluid retention[25].

This study has some limitations. The habitual diet was accessed by the retrospective method, which requires an individual to record and quantify commonly consumed foods[14]. Moreover, the self-reported food consumption may be underestimated. The nutritional status of patients was identified only by anthropometric variables, and considering the complexity of HF and the results above, other measures, such as biochemical variables have proven useful in assisting the diagnosis.

Conclusion

We concluded that part of HF outpatients display depletion of muscle reserves, especially among men. These individuals do not meet their energy requirements and have inadequate dietary intake of various nutrients, especially magnesium, zinc, iron, thiamine, calcium, potassium and sodium. There was no significant association between total dietary energy intake and nutritional status, assessed by BMI and AMA. We emphasize the necessity and importance of encouraging multidisciplinary monitoring, which may help the management of this complex syndrome[35], considering the frequent comorbidities which affect the correct diagnosis of the nutritional status, the treatment of cachexia, the correction of nutritional deficiencies and the best assessment of the patient's general condition.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Sources of Funding

There were no external funding sources for this study.

Study Association

This study is not associated with any post-graduation program.

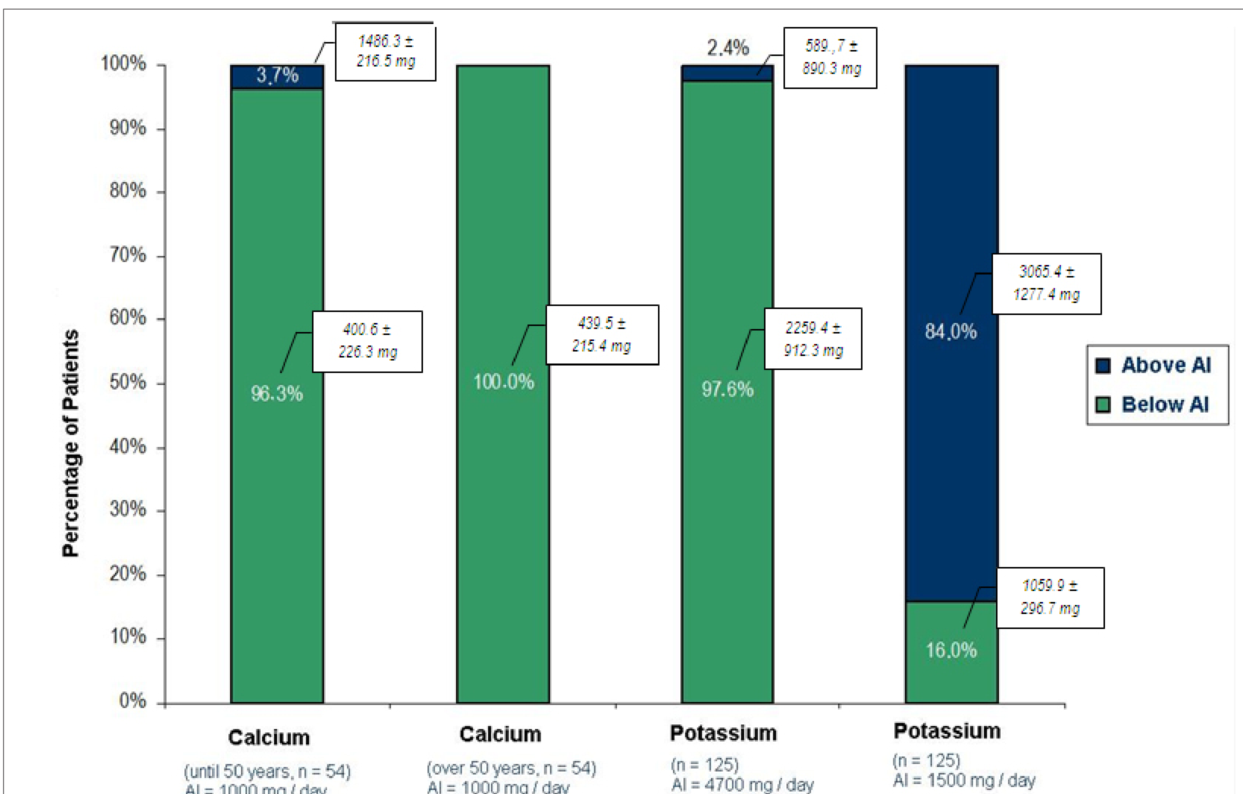

Figure 3 - Percentage of HF patients with habitual calcium, potassium and sodium intakes above or below recommended levels. AI - adequate intake. The values in the boxes are expressed as mean and standard deviation of consumption of each micronutrient, according to groups of patients who are above or below recommended levels.

References

1. Berry C, Clark AL. Catabolism in chronic heart failure. Eur Heart J. 2000; 21: 521-32.

2. Anker SD, Sharma R. The syndrome of cardiac cachexia. Int J Cardiol. 2002; 85: 51-66.

3. Ministério da Saúde. SIH/SUS. Informações de saúde: epidemiológicas e morbidade. [on line] DATASUS; 2008. [Acesso em 2008 abr 18]. Disponível em: <http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sih/cnv/miuf.defr> [2008 abr 18].

4. Bocchi EA, Cruz F, Guimarães G, Moreira LFP, Issa VS, Ferreira SMA, et al. A long-term prospective randomized controlled study using repetitive education at six-month intervals and monitoring for adherence in heart failure patients: the REMADHE study. Circulation. 2008. In press.

5. Witte KKA, Clark AL, Cleland JGF. Chronic heart failure and micronutrients. J Am Coll Cardiol. 2001; 37: 1765-74.

6. von Haehling S, Doehner W, Anker SD. Nutrition, metabolism, and the complex pathophysiology of cachexia in chronic heart failure. Cardiovasc Res. 2007; 73: 298-309.

7. Campillo B, Paillaud E, Uzan I, Merlier I, Abdellaoui M, Perennec J, et al. Value of body mass index in the detection of severe malnutrition: influence of the pathology and changes in anthropometric parameters. Clin Nutr. 2004; 23: 551-9.

8. Coats AJS. Advances in the non-drug, non-surgical, non-device management of chronic heart failure. Int J Cardiol. 2005; 100: 1-4.

9. Sociedade Brasileira da Cardiologia. Revisão das II Diretrizes da Sociedade Brasileira de Cardiologia para o diagnóstico e tratamento da insuficiência cardíaca. Arq Bras Cardiol. 2002; 79 (supl. 4):1-46.

10. World Health Organization (WHO). Obesity: preventing and managing the global epidemic. Report of a WHO Consultation. Geneva: World Health Organization; 2000. [WHO Technical Report Series, 894].

11. Gurney JM, Jelliffe DB. Arm anthropometry in nutritional assessment: normogram for rapid calculation of muscle circumference and cross-sectional muscle and fat areas. Am J Clin Nutr. 1973; 26: 912-5.

12. Heymsfield SB, McManus C, Smith J, Tevens V, Nixon DW. Anthropometric measurement of muscle mass: revised equations for calculating bone-free arm muscle area. Am J Clin Nutr. 1982; 36: 680-90.

13. Frisancho RA. New standards of weight and body composition by frame size and height for assessment of nutritional status of adults and the elderly. Am J Clin Nutr. 1990; 40: 808-19.

14. Thompson FE, Byers T. Dietary assessment resource manual. J Nutr. 1994; 124: 2245S-317S.

15. Anção MS, Cuppari L, Draibe SA, Sigulem D. Programa de apoio à nutrição - NutWin versão 1.5 [CD-ROM]. São Paulo: Departamento de Informática em Saúde - SPDM - Unifesp/EPM; 2002.

16. Moore C, Chowdhury Z, Young JB. Heart transplant nutrition programs: a national survey. J Heart Lung Transplant. 1991; 10: 50-5.

17. Food and Nutrition Board. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids. Washington (DC): National Academic Press; 2005.

18. Fisberg RM, Marchioni DML, Slater B. Recomendações nutricionais. In: Fisberg RM, Slater B, Marchioni DML, Martini LA. Inquéritos alimentares: métodos e bases científicos. Barueri: Manole; 2005. p. 190-236.

19. Poehlman ET, Scheffers J, Gottlieb SS, Fisher ML, Vaitekevicius P. Increased resting metabolic rate in patients with congestive heart failure. Ann Intern Med. 1994; 121: 860-2.

20. Kistorp C, Faber J, Galatius S, Gustafsson F, Frystyk J, Flyvbjerg A, et al. Plasma adiponectin, body mass index, and mortality in patients with chronic heart failure. Circulation. 2005; 112: 1756-62.

21. Kenchaiah S, Evans JC, Levy D, Wilson PWF, Benjamin EJ, Larson MG, et al. Obesity and the risk of heart failure. N Engl J Med. 2002; 347: 305-13.

22. Thrainsdottir IS, Aspelund T, Gudnason V, Malmberg K, Sigurdsson G, Thorgeirsson G, et al. Increasing glucose levels and BMI predict future heart failure: experience from the Reykjavík Study. Eur J Heart Fail. 2007; 9: 1051-7.

23. Lavie CJ, Osman AF, Milani RV, Mehra MR. Body composition and prognosis in chronic systolic heart failure: the obesity paradox. Am J Cardiol. 2003; 91: 891-4.

24. Fonarow GC, Srikanthan P, Costanzo MR, Cintron GB, Lopatin M. An obesity paradox in acute heart failure: analysis of body mass index and inhospital mortality for 108,927 patients in the Acute Decompensated Heart Failure National Registry. Am Heart J. 2007; 153: 74-81.

25. Payne-Emerson H, Lennie TA. Nutritional considerations in heart failure. Nurs Clin North Am. 2008; 43: 117-32.

26. Aquilani R, Opasich C, Verri M, Boschi F, Febo O, Pasini E, et al. Is nutritional intake adequate in chronic heart failure patients? J Am Coll Cardiol. 2003; 42: 1218-23.

27. Veloso LG, Pereira-Barretto AC, Oliveira-Junior MT, Munhoz RT, Morgado PC, Ramires JAF. Escore para avaliação do estado nutricional: seu valor na estratificação prognóstica de portadores de cardiomiopatia dilatada e insuficiência cardíaca avançada. Arq Bras Cardiol. 2006; 87: 178-84.

28. Catapano G, Pedone C, Nunziata E, Zizzo A, Passantino A, Incalzi RA. Nutrient intake and serum cytokine pattern in elderly people with heart failure. Eur J Heart Fail. 2008; 10: 428-34.

29. Price RJG, Witham MD, McMurdo MET. Defining the nutritional status and dietary intake of older heart failure patients. Eur J Cardiovasc Nurs. 2007; 6: 178-83.

30. Neubauer S, Horn M, Cramer M, Harre K, Newell JB, Peters W, et al. Myocardial phosphocreatine-to-ATP ratio is a predictor of mortality in patients with dilated cardiomyopathy. Circulation. 1997; 96: 2190-6.

31. Alsafwah S, LaGuardia SP, Arroyo M, Dockery BK, Bhattacharya SK, Ahokas RA, et al. Congestive heart failure is a systemic illness: a role for minerals and micronutrients. Clin Med Res. 2007; 5: 238-43.

32. Tang WHW, Tong W, Jain A, Francis GS, Harris CM, Young JB. Evaluation and long-term prognosis of new-onset, transient, and persistent anemia in ambulatory patients with chronic heart failure. J Am Coll Cardiol. 2008; 51: 569-76.

33. Sales ALF, Villacorta H, Reis L, Mesquita ET. Anemia como fator prognóstico em uma população hospitalizada por insuficiência cardíaca descompensada. Arq Bras Cardiol. 2005; 84: 237-40.

34. Cunha S, Albanesi-Filho FM, Bastos VLFC, Antelo DS, Souza MM. Níveis de tiamina, selênio e cobre em pacientes com cardiomiopatia dilatada idiopática em uso de diuréticos. Arq Bras Cardiol. 2002; 79: 454-9.

35. Ramírez EC, Martinez LC, Tejada AO, González VR, David RN, Lafuente EA. Effects of a nutritional intervention on body composition, clinical status, and quality of life in patients with heart failure. Nutrition. 2004; 20: 890-5.