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Does the type of disease and diet influence hospital weight loss? An analysis using the Generalized Estimating Equation method

Geovanna Godoy Ramos[1], Vânia Aparecida Leandro-Merhi[2,*], José Luis Braga de Aquino[3]

[1]Dietitian, Scholarship of Scientific Initiation, Faculty of Nutrition, PUC-Campinas-SP-Brazil.
[2,3]PhD, Professor Doctor of the Postgraduate Program in Health Sciences, Puc-Campinas-SP-Brazil.
*Corresponding author

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Abstract*—*Investigate weight evolution during hospitalization and its association with the type of disease and diet, over time. Retrospective study with 133 in-patients, investigating indicators of nutritional status, diet, disease, surgery and the evolution of body weight during hospitalization. The chi-square, Kruskal-Wallis tests and the method of Generalized Estimating Equation (GEE) were used for the study of weight evolution over time, depending on the diet and type of disease. Underweight according to body mass index, malnutrition by subjective global assessment and nutritional risk according to nutritional risk screening (NRS), were found in 19.5%, 27.8% and 46.6% patients, respectively. There was no influence of the type of diet on weight evolution over time (p=0.0779), but there was an influence of the disease (p=0.0100). In digestive neoplasms, a greater reduction in body weight was observed. The NRS was more sensitive in the diagnosis of malnutrition. The type of disease influenced weight loss, but the type of diet did not influence the evolution of body weight over time.

I. INTRODUCTION

Many studies have shown that hospitalized patients endure malnutrition, and ESPEN (European Society of Clinical Nutrition and Metabolism) published a consensus [1] on malnutrition in hospitalized patients, emphasizing the importance of some anthropometric indicators, such as the reduction of the body mass index (BMI) and this reduction was also considered for the evaluation of malnutrition by the World Health Organization (WHO) [2].

Other instruments have been used to determine nutritional risk in hospitalized patients, such as nutritional risk screening (NRS), subjective global assessment, among others [3,4,5,6,7]; the relevance of NRS was highlighted in a recent study [8] that showed that the reduction of BMI and recent weight loss were the factors that most contributed to the diagnosis of nutritional risk and the joint use of NRS with serum albumin [9] also proved to be useful in patients' nutritional screening A reduced risk of hospitalization was associated with weight gain while weight loss was associated with a higher rate of hospitalization, especially of low weight patients [10]. Another interesting recent study [11] that investigated characteristics and outcomes of malnourished patients, pointed out that malnutrition is still underestimated, and that among the criteria used to identify malnourished patients the most important were the reduction of energy consumption and weight loss.

The objective of this study was to investigate the weight evolution during hospitalization and its association with the type of disease and diet, analyzed over time using the Generalized Estimating Equations (GEE) method.

II. METHOD

Study design and ethical aspects:-

A retrospective study was carried out with data collection in medical records of adult patients hospitalized by the Unified Health System (SUS), in a surgery ward of a university hospital in the State of São Paulo, Brazil. The indicators of nutritional status, type of prescribed diet, type of disease and surgery, and body weight records during hospitalization were surveyed. The study was approved by the Research Ethics Committee (CEP) of the institution.

Study participants:-

We included hospitalized patients of both genders over the age of 20 years, without terminal illnesses, with at least three records of measurement of body weight on different days of hospitalization and with all clinical, nutritional data and type of prescribed diet, duly registered in the medical records. Patients admitted only for clinical investigation and those who had not undergone nutritional assessment in the first 48 hours of hospitalization were excluded. Thus, the sample size included 133 in-patients.

Procedures:-

All screening and risk assessment and nutritional status instruments were performed within the first 48 hours of hospitalization, using the nutritional risk screening (NRS), subjective global assessment (SGA), anthropometry and laboratory tests (hemoglobin, hematocrit and lymphocyte count). Anthropometric measurements included: body weight, body mass index (BMI), arm circumference (AC), triceps skinfold (TSF) and arm muscle circumference (AMC). The diagnosis at admission (type of disease), type of surgery, type of prescribed diet (whether oral, enteral or parenteral diet and fasting), prescription of hypercaloric and hyperproteic nutritional supplement, length of stay, age and gender were investigated. All this information was properly documented in the medical records of the hospital.

For the classification and analysis of the evaluated indicators, the cutoff points standardized by the relevant literature for the NRS (*with and without nutritional risk*) were adopted [12,13]; SGA (*well nourished and malnourished*) [14]; BMI (*normal, overweight and underweight, for adults and the elderly*) [2,15]; AC, TSF and AMC (*percentile classification* $\leq$ *P15, P15-P85 and* $\geq$ *P85*) [16,17] and laboratory tests [18]. Finally, body weight measurements on 3 different days of hospitalization were recorded among all the variables studied.

Statistical Analysis:-

Initially, the characteristics of the studied population were described and compared in relation to the type of diet prescribed. Subsequently, weight gain was related to the type of diet prescribed and the type of disease.

Categorical variables were expressed as frequency and percentage, and continuous variables were expressed as mean and standard deviation. To compare proportions, the Chi-square test or Fisher's exact test was used; when necessary. To compare the numerical measures summarized between the groups on the prescribed diet, the Kruskal-Wallis test was used, followed by the Dunn test to locate the differences; when necessary. For the study of weight evolution during the hospitalization period, depending on the prescribed diet and the type of disease, the Generalized Estimating Equations (GEE) method was used in this study. The level of significance adopted for the statistical tests was 5% [19,20].

III. RESULTS

The study consisted of 133 in-patients with a mean age of 60.7±12.7 years, 64.7% (n=86) male and 35.3% (n=47) female, who were hospitalized during approximately 15.1±11.5 days. At the beginning of hospitalization, these patients exhibited a body weight of 69.4±16.7 kg; BMI 25.4±6.2 kg/m^2; lymphocytes 1,658.4±912.2 cells/mm^3 and hemoglobin 11.4±2.3 g/dl. The most frequent diseases were: vascular diseases 29.3% (n=39); colorectal neoplasms 24.1% (n=32); head and neck neoplasms 13.5% (n=18); digestive tract diseases 12.8% (n=17); digestive neoplasms 12% (n=16) and fractures 8.3% (n=11). In this population, 73.7% (n=98) of the patients underwent some type of surgical procedure, including rectosigmoidectomy (18.4%); head and neck surgery (16.3%); colectomy (14.3%); esophagectomy (9.2%); exploratory laparotomy (8.2%); cardiac surgery (7.1%); gastrectomy (7.1%); cholecystectomy (4.1%); amputation (3.1%); vascular surgery (3.1%); debridement (3.1%); osteosynthesis (3.1%); appendectomy (1%); ileostomy (1%) and tracheostomy (1%).

Regarding nutritional indicators at the beginning of hospitalization, 19.5% patients (n=26) were underweight according to BMI and 39.1% (n=52); 20.3% (n=27) and 42.1% (n=56), were classified as equal to or

below the 15th percentile (≤P15) for AC, TSF and AMC, respectively. According to the SGA, 27.8% (n=37) patients were malnourished and with the NRS it was found that 46.6% (n=62) patients were at nutritional risk. Regarding the type of diet at the beginning of hospitalization, 66.2% (n=88) of the patients were on oral diet; 16.5% (n=22) on enteral and parenteral diet and 17.3% (23) on oral fasting. The use of oral nutritional supplementation was observed in 6.8% (n=9) of the patients. No patient died.

A comparison was made between all the variables studied (numerical, categorical variables, body composition and nutritional status at the beginning of hospitalization) and the types of diet in the first dietary prescription, with the aim of verifying whether any characterization variable at the beginning of hospital stay, was associated with the type of diet. When the relationship between the three types of diets prescribed in the first evaluation and all the variables was assessed, there was a significant difference only in body weight (p=0.0470), BMI (p=0.0147) and hemoglobin (p=0.0377) (*analyzed by the Kruskal-Wallis test, followed by the Dunn test to find the differences*); in gender (p=0.0152), type of disease (<0.0001), surgery (p=0.0007), in AC (p=0.0094) and in SGA (p=0.0278) (*analyzed by the chi- square test).*

In the relationship between the evolution of body weight during hospitalization and the type of diet prescribed, analyzed by the GEE method, there was no significant influence of the type of diet on weight evolution over time (hospital stay) (p=0.0779) (Table 1). In relation to the evolution of body weight over time (hospital stay) and the type of disease, there was a statistically significant difference (p = 0.0100), using the GEE method (Table 2). It was found that in digestive neoplasms, the reduction in body weight over time was greater in relation to other diseases.

Table 1. Association between body weight throughout hospitalization and the type of diet prescribed, analyzed by the GEE method.

Diets	Weight	N	X±SD	Median
Prescribed diet [A]				
Oral	Body weight[1]	88	71.23±16.82	70.00
	Body weight[2]	88	71.05±16.71	69.58
	Body weight[3]	88	70.77±16.69	70.65
Fasting	Body weight[1]	23	70.35±16.75	72.00
	Body weight[2]	23	71.00±16.84	73.00
	Body weight[3]	23	70.27±16.39	69.00
Enteral/Parenteral	Body weight[1]	22	60.90±14.32	62.18
	Body weight[2]	22	59.99±13.60	59.20
	Body weight[3]	22	60.07±13.18	59.10
Prescribed diet [B]				
Oral	Body weight[1]	88	70.61±16.97	68.73
	Body weight[2]	88	70.78±16.82	67.75
	Body weight[3]	88	70.37±16.92	67.50
Fasting	Body weight[1]	22	72.61±16.03	73.35
	Body weight[2]	22	71.40±1634	73.10
	Body weight[3]	22	70.92±15.68	71.83
Enteral/Parenteral	Body weight[1]	23	61.55±14.73	62.50
	Body weight[2]	23	61.10±14.46	59.20
	Body weight[3]	23	61.41±13.84	59.30
Prescribed diet [C]				
Oral	Body weight[1]	97	71.28±15.90	70.00
	Body weight[2]	97	71.14±15.90	70.00
	Body weight[3]	97	70.77±15.93	70.30
Fasting	Body weight[1]	8	70.28±13.14	71.00
	Body weight[2]	8	69.86±13.81	71.00
	Body weight[3]	8	68.70±13.73	68.05
Enteral/Parenteral	Body weight[1]	25	63.05±19.49	61.85

	Body weight[2]	25	62.44±19.13	59.20
	Body weight[3]	25	62.66±18.30	59.30

GEE: Generalized Estimating Equations-GEE.

A:- first prescription; B:- second prescription; C:- third prescription.

1:- first assessment; 2:- second assessment; 3:- third assessment.

p=0,0759 value (GEE); without significant influence of the type of diet prescribed on body weight during hospitalization.

Table 2. Association between body weight assessment during hospitalization and the type of disease, analyzed by the GEE method.

Diseases	Weight	N	X±SD	Median
Digestive tract disease	Body weight[1]	17	75.49±16.08	77.00
	Body weight[2]	17	74.71±16.29	77.00
	Body weight[3]	17	73.73±16.58	77.00
Vascular disease	Body weight[1]	39	71.36±14.93	70.00
	Body weight[2]	39	71.16±15.05	69.90
	Body weight[3]	39	70.75±15.05	67.90
Fracture	Body weight[1]	11	77.25±15.85	74.00
	Body weight[2]	11	76.50±16.02	74.00
	Body weight[3]	11	76.19±16.18	74.00
Colon rectal neoplasm	Body weight[1]	32	70.23±18.79	71.55
	Body weight[2]	32	70.97±18.47	7250
	Body weight[3]	32	70.33±18.15	70.73
Head and neck neoplasm	Body weight[1]	18	64.02±14.87	64.95
	Body weight[2]	18	64.12±14.28	63.35
	Body weight[3]	18	64.54±14.99	65.00
Digestive neoplasm	Body weight[1]	16	56.91±13.35	56.45
	Body weight[2]	16	55.81±12.96	54.15
	Body weight[3]	16	56.39±12.06	52.95

GEE: Generalized Estimating Equations-GEE.

1:- first assessment; 2:- second assessment; 3:- third assessment.

p=0,0100 value (GEE); significant difference in body weight for diseases. Differences between: - digestive tract disease and digestive neoplasia; fracture and digestive neoplasia; colon rectal cancer and digestive neoplasm.

IV. DISCUSSION

This study investigated the evolution of body weight during hospitalization and its relationship with adult in-patients' clinical and nutritional status variables. As evidenced by the findings, NRS was more sensitive than the other indicators in the diagnosis of malnutrition. The initial hypothesis of this investigation was to assess any influence of a few indicators of nutritional status and the type of diet prescribed on the weight evolution during hospitalization, and no influence was observed here. However, the type of disease on the evolution of body weight over time was observed, with a greater reduction in weight over time in digestive neoplasm; in relation to other diseases. In the present study, the GEE method was adopted as the method of analysis for the study of body weight over time, as a function of the type of diet prescribed and the type of disease. The selection of this method of analysis allowed better adjustments in relation to the distribution of variables. With this method of analysis (GEE), it was possible to model both the response (body weight) and the factor under study (diet prescribed and type of disease), with repeated measurements (assessments over time).

In a retrospective study [11] with adult patients, it was observed that 62% of the patients exhibited malnutrition due to chronic disease, and the most common criteria for identifying malnourished patients were weight loss and reduced energy consumption. It has been reported that during hospitalization, significant changes in nutritional status can occur [21], with important changes in anthropometric and laboratory indicators.

As indicated by ESPEN [1], low BMI in conjunction with weight loss can constitute a diagnosis of malnutrition in patients at nutritional risk; in addition, the Malnutrition Universal Screening Tool (MUST) [22] related to the ESPEN criteria for the definition of malnutrition should also be considered.

Multivariate models showed a decline in nutritional status [23] by SGA and loss of body weight, being significantly associated with longer hospital stays. In an investigation of the prevalence of malnutrition with the criteria of weight loss and BMI [24], preoperative malnutrition was associated with an increased risk of serious complications. And an additional study [25] further pointed out that self-reported weight loss can be considered an important prognostic factor in hospitalized patients. Another study that investigated the effects of nutritional support in hospitalized patients with malnutrition [26], reported increased energy and protein consumption, and body weight. There are also studies showing that there was no influence of the type of diet on weight loss in hospitalized patients [27] and that weight loss during hospitalization was related only to sex and type of disease [28].

The relevance of assessing body weight loss has also been reported in several studies with different clinical situations [29], which can also be associated with other markers of malnutrition, such as laboratory tests, body composition and muscle strength assessment, energy consumption and nutritional screening instruments assessment [30].

The limitations of this study include the loss of some data, inherent to the type of retrospective study and data collection in medical records. Another limitation refers to the fact that acceptance of the hospital diet was not evaluated, but only the dietary prescription adopted at the beginning of hospitalization. However, this type of retrospective observational study has the advantage of being able to show the findings and results of the hospital routine, as it actually occurs in the hospital, and not in a controlled manner.

V. CONCLUSION

The NRS was more sensitive in the diagnosis of malnutrition. The type of disease influenced weight loss, but the type of diet did not influence the evolution of body weight over time.

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REFERENCES

[1] Cederholm T, Bosaeus I, Barazzoni R, et al. (2015). Diagnostic criteria for malnutrition - An ESPEN Consensus Statement. *Clin Nutr,* 34:335–40.

[2] World Health Organization (WHO). (1998). Obesity: Preventing and managing the global epidemic - Report of a WHO Consultation on obesity. Geneva: WHO.

[3] Velasco C, Garcia E, Rodríguez V, Frias L, Garriga R, Álzarez J, Garcia-Peris P, León M. (2011). Comparison of four nutritional screening tools to detect nutricional risk in hospitalized patients: a multicentre study. *European Journal of Clinical Nutrition*, 65:269-274.

[4] Mercadal-Orfila G, Lluch-Taltavull J, Campillo-Artero C, Torrent-Quetglas M. (2012). Association between nutritional risk based on the NRS-2002 test and hospital morbidity and mortality. *Nutr Hosp* , 27(4):1248-1254.

[5] Raslan M, Gonzalez MC, Dias MCG, Nascimento M, Castro M, Marques P, Segatto S, Torrinhas RS, Cecconello I, Waitzberg DL. (2010).Comparison of nutritional risk screening tools for predicting clinical outcomes in hospitalized patients. *Nutrition*, 26:721-726.

[6] Raslan M, Gonzalez MC, Torrinhas RSMM, Ravacci GR, Pereira JCR, Waitzberg DL. (2011). Complementarity of Subjective Global Assessment (SGA) and Nutritional Risk Screening 2002 (NRS 2002) for predicting poor clinical outcomes in hospitalized patients. *Clinical Nutrition*, 30:49-53.

[7] Leandro-Merhi VA, Braga de Aquino JL. (2015). Comparison of nutritional diagnosis methods and prediction of clinical outcomes in patients with neoplasms and digestive tract diseases. *Clin Nutr,* 34(4):647-51.

[8] Barbosa AAO, Vicentini AP, Langa FR. (2019). Comparison of NRS-2002 criteria with nutritional risk in hospitalized patients. *Cien Saude Colet,* 24(9):3325-3334.

[9] Takaoka A, Sasaki M, Nakanishi N, Kurihara M, Ohi A, Bamba S, Andoh A. (2017). Nutritional Screening and Clinical Outcome in Hospitalized Patients with Crohn's Disease. *Ann Nutr Metab,* 71(3-4):266-272.

[10] Carrero JJ, Cabezas-Rodríguez I, Qureshi AR, Floege J, Ketteler M, London G, Locatelli F, Memmos D, Goldsmith D, Ferreira A, Nagy J, Teplan V, Martínez-Salgado C, Fernández-Martín JL, Zoccali C, Cannata-Andia JB; COSMOS group. (2018). Risk of hospitalization associated with body mass index and weight changes among prevalent haemodialysis patients. *Nefrologia*, 38(5):520-527.

[11] Vest MT, Papas MA, Shapero M, McGraw P, Capizzi A, Jurkovitz C. (2018). Characteristics and Outcomes of Adult Inpatients With Malnutrition. *JPEN J Parenter Enteral Nutr* , 42(6):1009-1016.

[12] Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. (2003). ESPEN guidelines for nutrition screening 2002. *Clinical Nutrition*, 22(4):415-21.

[13] Kondrup J, Rasmussen HH, Hamberg O, Stanga Z, ESPEN Working Group. (2003). Nutritional risk screening (NRS 2002): a new method based on a analysis of controlled clinical trials. *Clinical Nutrition,* 22(3):321-336.

[14] Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA, Jeejeebhoy KN. (1987). What is subjective global assessment of nutritional status? *JPEN*, 11:8-13.

[15] Pan-American Health Organization. 36a Reunión del Comitê Asesor de Investigaciones en Salud - Encuesta Multicêntrica - Salud Bienestar y Envejecimiento (SABE) en América Latina y el Caribe: Informe preliminar; 2001 Jul 9-11, Kingston, Jamaica. Washington (DC): Pan-American Health Organization. Disponible en: http://www.opas.org/program/sabe.htm.

[16] Frisancho AR. (1990). Anthropometric standards for the assessment of growth and nutritional status. Michigan: The University of Michigan Press.

[17] Burr ML, Phillips MK. (1984). Anthropometric norms in the elderly. *Br J Nutr* 1984; 51:165-9.

[18] Calixto-Lima L, Reis NT. (2012). Interpretação de exames laboratoriais aplicados à nutrição. Ed. Rubio. Rio de Janeiro.

[19] Brown H, Prescott R. (2006). *Applied Mixed Models in Medicine*. 2ª ed. John Wiley & Sons Ltda, Inglaterra.

[20] [20]. Conover WJ. (1971). *Practical Nonparametric Statistics*. John Wiley & Sons Inc. Nova Iorque.

[21] Rinninella E, Cintoni M, De Lorenzo A, Anselmi G, Gagliardi L, Addolorato G, Miggiano GAD, Gasbarrini A, Mele MC. (2019). May nutritional status worsen during hospital stay? A sub-group analysis from a cross-sectional study. *Intern Emerg Med*, 14(1):51-57. doi: 10.1007/s11739-018-1944-5.

[22] Poulia KA, Klek S, Doundoulakis I, Bouras E, Karayiannis D, Baschali A, Passakiotou M, Chourdakis M. (2017). The two most popular malnutrition screening tools in the light of the new ESPEN consensus definition of the diagnostic criteria for malnutrition. *Clin Nutr*, 36(4):1130-1135. doi: 10.1016/j.clnu.2016.07.014.

[23] Allard JP, Keller H, Jeejeebhoy KN, Laporte M, Duerksen DR, Gramlich L, Payette H, Bernier P, Davidson B, Teterina A, Lou W. (2016). Decline in nutritional status is associated with prolonged length of stay in hospitalized patients admitted for 7 days or more: A prospective cohort study. *Clin Nutr*, 35(1):144-152. doi: 10.1016/j.clnu.2015.01.009.

[24] Skeie E Tangvik RJ, Nymo LS, Harthug S, Lassen K, Viste A. (2019). Weight loss and BMI criteria in GLIM's definition of malnutrition is associated with postoperative complications following abdominal resections - Results from a National Quality Registry. *Clin Nutr*, 39(5):1593–1599.

[25] Barazzoni R, Sulz I, Schindler K, Bischoff SC, Gortan Cappellari G, Hiesmayr M; nutrition Day Research Group. (2019). A negative impact of recent weight loss on in-hospital mortality is not modified by overweight and obesity. *Clin Nutr*. 39(8): 2510–2516.

[26] Bally MR, Blaser Yildirim PZ, Bounoure L, Gloy VL, Mueller B, Briel M, Schuetz P. (2016). Nutritional Support and Outcomes in Malnourished Medical Inpatients: A Systematic Review and Meta-analysis. *JAMA Intern Med*, 176(1):43-53. doi: 10.1001/jamainternmed.2015.6587.

[27] Vieira Teles M, Leandro-Merhi VA, Braga de Aquino JL, Teixeira Mendes ED, Mendonça JA. (2020). Do more overweight patients at admission lose weight during hospitalization ? *Nutr Clín Diet Hosp*, 40(3):176-179. doi: 10.12873/403leandro

[28] Leandro-Merhi VA, Srebernich SM, Gonçalves GM, de Aquino JL. (2015). In-hospital weight loss, prescribed diet and food acceptance. *Arq Bras Cir Dig*, 28(1):8-12. doi:10.1590/S0102-67202015000100003

[29] McDonald MN, Wouters EFM, Rutten E, Casaburi R, Rennard SI, Lomas DA, Bamman M, Celli B, Agusti A, Tal-Singer R, Hersh CP, Dransfield M, Silverman EK. (2019). It's more than low BMI: prevalence of cachexia and associated mortality in COPD. *Respir Res*,20(1):100. doi: 10.1186/s12931-019-1073-3.

[30] Castillo-Martínez L, Castro-Eguiluz D, Copca-Mendoza ET, Pérez-Camargo DA, Reyes-Torres CA, Ávila EA, López-Córdova G, Fuentes-Hernández MR, Cetina-Pérez L, Milke-García MDP. (2018). Nutritional Assessment Tools for the Identification of Malnutrition and Nutritional Risk Associated with Cancer Treatment. *Rev Invest Clin*, 70(3):121-125. doi: 10.24875/RIC.18002524.