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ORIGINAL

Can hospitalized patients adequately estimate their own food intake? A cross-sectional pilot study

Pacientes hospitalizados estimam adequadamente sua ingestão alimentar? Um estudo piloto transversal

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ABSTRACT

Objective

To assess and identify factors linked to the accuracy of patients' food intake estimations through a self-monitoring instrument filled in by the patient.

Methods

This cross-sectional study approached adult hospital patients subjected to regular or therapeutic diets. The actual food intake percentage was obtained by the ratio between the actual food intake and the amount of food served x 100. Patients had to complete a food chart including 9 circles representing plates of food in percentages (increasing scale

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of 12.5%) to represent their food intake at lunch and/or dinner. The Bland-Altman method assessed the agreement between the actual and the estimated values. The associations between variables (age, sex, hospitalization day, diet prescription, amount of food served and actual food intake percentage) and the accuracy of the food intake estimation (adequate ±10%, overestimated and underestimated) were evaluated through univariate multinomial logistic regression.

Results

Ninety-six patients were evaluated (51.0% male; 44.0±15.8 years of age). The Bland-Altman analysis showed good agreement between the actual and the estimated food intake. The actual food intake percentage was the only variable associated with the accuracy of the food intake estimation.

Conclusion

Most patients (~70%) adequately estimated their food intake using the 9-point food chart tested. Furthermore, the only factor linked to the accuracy of the food intake estimation was the actual food-intake percentage. These findings provide preliminary support for the usefulness of this instrument. However, it must be tested in a representative sample of hospitalized patients.

Keywords: Food intake. Nutrition assessment. Nutrition therapy.

RESUMO

Objetivo

Avaliar e identificar fatores associados à acurácia da estimativa de ingestão alimentar por meio de um instrumento de monitoramento preenchido pelo próprio paciente.

Métodos

O presente estudo transversal incluiu adultos hospitalizados em uso de dietas regulares ou terapêuticas. A porcentagem real de ingestão alimentar foi obtida pela razão entre a ingestão alimentar real e a quantidade servida x100. Os pacientes preencheram um instrumento imagético incluindo nove círculos que representavam pratos de comida em porcentagens (escala crescente de 12,5%) da sua ingestão alimentar no almoço e/ou jantar. O método de Bland-Altman foi usado para avaliar a concordância entre os valores reais e estimados. Também foram avaliadas associações entre variáveis (idade, sexo, dia de hospitalização, prescrição dietética, quantidade de comida servida e porcentagem real de ingestão alimentar) e a acurácia da estimativa de ingestão alimentar (adequada ±10%, superestimada e subestimada) através de regressão logística multinomial univariada.

Resultados

Foram avaliados 96 pacientes (51% homens; 44.0±15.8 anos de idade). A análise de Bland-Altman mostrou boa concordância entre a ingestão alimentar real e estimada. A porcentagem real de ingestão alimentar foi a única variável associada à acurácia da estimativa de ingestão alimentar.

Conclusão

A maioria dos pacientes (~70%) estimaram adequadamente sua ingestão alimentar usando o instrumento imagético testado. Além disso, o único fator associado à acurácia da estimativa de ingestão alimentar foi a porcentagem real de ingestão alimentar. Esses achados fornecem suporte preliminar para a utilidade desse instrumento, porém, é necessário que seja testado em uma amostra representativa de pacientes hospitalizados.

Palavras-chave: *Ingestão alimentar. Avaliação nutricional. Terapia nutricional.*

INTRODUCTION

The relationship between food intake, food supply, and nutritional needs may vary during a hospitalization. Studies conducted in several countries have shown that 10.3% to 61.5% of hospital patients eat their entire meals [1-3]. A study of the Nutrition Day (nDay) in Latin America showed that more than 40% of hospital patients eat half or less than half of their meals [4]. Patients on therapeutic diets, mainly those on low-sodium and texture-modified ones [5,6], often record lower intake than those in regular diets. Some studies showed that patients subjected to nutrient-modified diets and/or consistency-modified diets

do not meet energy and protein requirements [7-9]. Low food intake can lead to higher infection rates, longer hospital stays, as well as higher hospital readmission and mortality rates [4,10-12]. Agarwal *et al.* [10] and Hiesmayr *et al.* [11] found that low food intake is also an independent risk factor for in-hospital deaths. Therefore, the evaluation of food-intake adequacy in hospitalized patients is essential, since it can help the professional to act early and either improve the food intake or prescribe nutritional support to prevent malnutrition [7,13-15].

There are several methods to evaluate the food intake of hospital patients. The direct food-weighing method is the gold standard, but it is unfeasible for clinical practice [6,16,17]. Other methods include dietary assessment methods, such as the 24-hour food recall [9,18,19], food intake Visual/Verbal Analogue Scale [20], digital photography [21], energy and protein intake expressed in points [22,23], and food charts, including visual food-intake percentage-estimation charts [3-5,10,11,24-35].

There is great variation among the visual food-intake percentage estimation charts of hospital patients. Some methods are exclusively qualitative and lack figures representing food-intake percentages [5,28]. However, most studies include plate diagram sheets (plate diagrams representing food intake and leftover percentages) associated with qualitative traits and/or numerical traits ranging from 4 to 11 points [3-5,10,11,24-35]. Good accuracy and agreement between visual estimates and food weighing have been found in several studies [26,27,29,36-38]. Previous studies have shown that the accuracy of the food-intake estimation may be affected by several factors such as the age [39,40] and sex of the patient [39,41,42], the type, presentation and texture of the food [40,43,44], the amount of food served [40,43,44], length of hospital stay [45] and food intake percentage [39].

Most of the methods previously mentioned were performed by health professionals (dietitians or nursing staff) who estimated the patients' food intake, except for the ones performed by the patients themselves [9,11,22-24,26,37]. Few studies have assessed the accuracy of the visual food-intake estimation performed by the patients themselves through instruments that indicate the estimated food intake percentages [21,37]. Our study has proposed a food intake estimation using a 12.5-estimate unit 9-point scale performed by the patient, while previous studies have used a 25.0-estimate 5-point food chart, and a diet prescription evaluation (regular or therapeutic diet) [21,31-34,37]. Moreover, we presented an analysis of possible factors that can influence the food-intake estimation accuracy in the specific population of hospitalized patients. Our hypothesis was that patients on a regular diet would estimate their own food intake better than patients on a therapeutic diet, since therapeutic diets may have changes in the texture, presentation, and taste of the meals which could influence the food-intake estimation [40,43,44]. Therefore, the purpose of this pilot study was to assess the accuracy of the food-intake estimation using a self-monitoring instrument filled in by the patient, and identify factors linked to the accuracy of food-intake estimations.

METHODS

This was a cross-sectional pilot study carried out with 96 hospitalized patients recruited in the clinical ward of the Clinical Hospital of the Federal University of *Uberlândia, Minas Gerais*, Brazil, from October 2016 to October 2017. The research was approved by the Human Research Ethics Committee (CAAE nº 60059416.9.0000.5152).

Patients were selected based on the following inclusion criteria: be an adult (age ≥19 years) who is following an oral diet in the first three days of hospitalization. The patients were divided into two groups by diet prescription: regular diets (without any changes in texture or nutrient composition) or therapeutic diets

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(with changes in texture or nutrient composition). All diets evaluated were solid, and liquid diets were not included. Participants were alert, briefed, and agreed to participate in the research, signing the Informed Consent Form. Those who were unable to answer the questionnaires and/or were undergoing enteral nutritional therapy and/or parenteral nutrition therapy concurrent to oral diets were excluded from the study.

The patients were informed the research would analyze the food intake estimation using food charts, without a more detailed explanation about the comparison between types of diets or the factors that could influence the food intake estimation. The researcher delivered information on how to use the food charts, in order to avoid misinterpretation. The patients filled in the instrument right after they finished their meals, when the food containers were still with them.

The sample was characterized using sociodemographic (sex and age) and clinical (hospitalization days, medical specialty, general symptoms, and dietary prescription) data. Both data types were collected from the patients' electronic records.

The actual food intake was measured through direct meal weighing, before and after the patient's intake, by two undergraduate nutrition students [26,29].

The surveyed hospital serves meals in round foam food containers with lids and without partitions (dimensions: 187 mm x 52 mm, capacity: 750 ml). The food intake was measured based on the difference between the amount served initially and the leftovers in each patient's container. The weight of the container was discarded. These amounts were measured based on a food scale (brand CBR – 400, 10 kg capacity and 1 g accuracy). All patients were surveyed within one day, at lunch and/or dinner.

The actual food-intake percentage was measured based on the ratio between the amount eaten and the amount served multiplied by 100.

The visual food-intake estimation was performed based on a food chart with 9 fraction circles representing the food-intake percentages (0%, 12.5%, 25%, 37.5%, 50%; 62.5%, 75%, 87.5%, 100%) (Figure 1) [46].

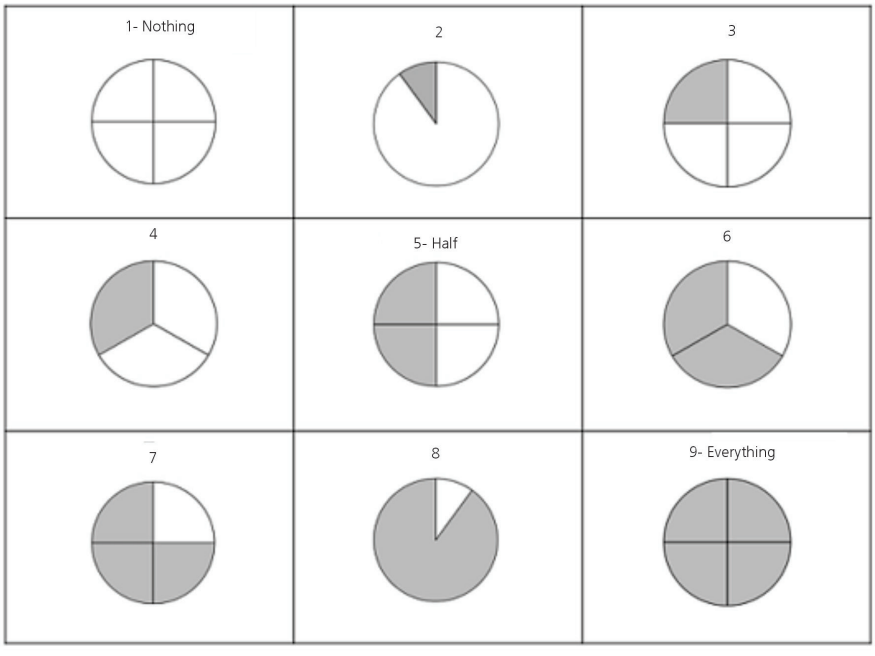

Figure 1 – Food chart with 9 fraction circles representing food intake percentages. *Uberlândia* (MG), Brazil, 2016-2017.
Note: 1: 0%; 2: 12.5%; 3: 25%; 4: 37.5%; 5: 50%; 6: 62.5%; 7: 75%; 8: 87.5%; 9: 100%.

The accuracy of the amount of food eaten was measured based on the difference between the estimated percentage and the actual intake percentage. The formula used to calculate the accuracy was: food intake estimation accuracy = visual food-intake estimation (%) – actual food intake (%).

The classification was based on the following criteria [47]:

– Underestimates: difference greater than or equal to -10;

– Adequate estimates: difference between -10 and 10;

– Overestimates: difference greater than or equal to 10.

Normality was analyzed by the Shapiro-Wilk test. A descriptive variable analysis was performed according to the following characteristics: age, sex, medical specialty, general symptoms, hospitalization day, and type of diet prescribed. Categorical variables were classified as relative frequencies and continuous variables were classified as mean and standard deviations, or as median, minimum, and maximum deviations.

The data agreement between the visual estimation and the actual food intake was evaluated through the Bland-Altman analysis.

The relative frequencies of the food-intake estimation accuracy classification (underestimates, adequate estimates and overestimates) were analyzed by the Kruskall-Wallis test and compared through the Bonferroni multiple-comparison correction method.

Associations between independent variables (age, sex, hospitalization day, diet prescription, amount of food served, and actual food intake percentage) and the food-intake estimation accuracy (adequate, overestimated, and underestimated) were evaluated through univariate multinomial logistic regression [48]. All test analyses were performed in SPSS (version 20), at a 5% significance level.

RESULTS

Ninety-six (96) patients were evaluated (51.0% male; 44.0±15.8 years of age). With regards to dietary prescriptions, approximately 36% of the prescribed diets were regular, with no nutritional restrictions or changes in consistency. A total of 143 meals were evaluated, 72 of which were lunches (50.3%) and 71 were dinners (49.6%). Fifty (50) patients evaluated both meals (52.1%) (Table 1).

Table 1 – Sample characteristics of the subjects (n=96). *Uberlândia* (MG), Brazil, 2016-2017.

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Variables	Total
Age (years) – M±SD	44.0±15.8
Sex – n (%)	
Male	49 (51.0)
Female	47 (49.0)
Diet Prescription – n (%)	
Therapeutic[1]	61 (63.6)
Regular	35 (36.4)
Medical specialty – n (%)	
Cardiology	31 (32.3)
Endocrinology	14 (14.6)
Others[2]	14 (14.6)
Nephrology	13 (13.5)
Gastroenterology	12 (12.5)
Neurology	8 (8.3)
Vascular	4 (4.2)

Table 1 – Sample characteristics of the subjects (n=96). *Uberlândia* (MG), Brazil, 2016-2017.

Variables	Total
Hospitalization day – n (%)	
1st	50 (52.1)
2nd	24 (25.0)
3rd	22 (22.9)
General symptoms	
Lunch – n (%)	
Intestinal Gases	20 (37.7)
Abdominal pain	9 (17)
Others[3]	9 (17)
Abdominal distension	6 (11.3)
Nausea	5 (9.4)
Vomit	2 (3.8)
Diarrhea	2 (3.8)
Dinner – n (%)	
Intestinal Gases	16 (23.9)
Others[3]	15 (22.4)
Abdominal distension	13 (19.4)
Abdominal pain	12 (17.9)
Nausea	5 (7.5)
Vomit	3 (4.5)
Diarrhea	3 (4.5)

Note: [1]From the larger to the smaller presence: diabetes mellitus (ajusted energy intake), mixed types (more than one alteration – i.e: diabetes mellitus and low sodium), low sodium, soft texture, low fat, pureed texture, and low in dietary fiber. [2]Pneumology, General Internal Medicine, and patients who had had no conclusive diagnosis. [3]Patients' self-reported symptoms like headache or other extra gastrointestinal pain.

The Bland-Altman analysis showed good agreement between the patients' actual and estimated intakes (all patients: bias=1.41, p=0.28; on therapeutic diets only: bias=0.53, p=0.75; on regular diets: bias=2.90, p=0.17). Based on the records, 5.5% and 3.8% of the therapeutic and regular diet meals, respectively, were outside the limits of agreement between visual estimates and the actual food intake (Figure 2). This means that, according to this method, the food-intake estimation made by the patients agreed with the actual food intake for most patients.

Underestimate, adequate estimates, and overestimate values set for the classification of the food-intake estimation accuracy were similar between patients on regular and therapeutic diets. In addition, 67.9% of patients on a regular diet and 73.3% on a therapeutic diet adequately estimated their food intake (Table 2).

The actual food intake percentage was the only variable significantly associated with the food-intake estimation in the univariate multinomial regression. Thus, the Odds Ratio (OR) showed a 3% decrease in the probability of food intake under or overestimation for every 1% increase in food intake (Table 3).

DISCUSSION

The present study assessed the accuracy of the food-intake estimation using a self-monitoring instrument filled in by the patient, and identified factors linked to food-intake estimation accuracy. There was good agreement between analyses based on the Bland-Altman methods (weighing vs. visual estimation).

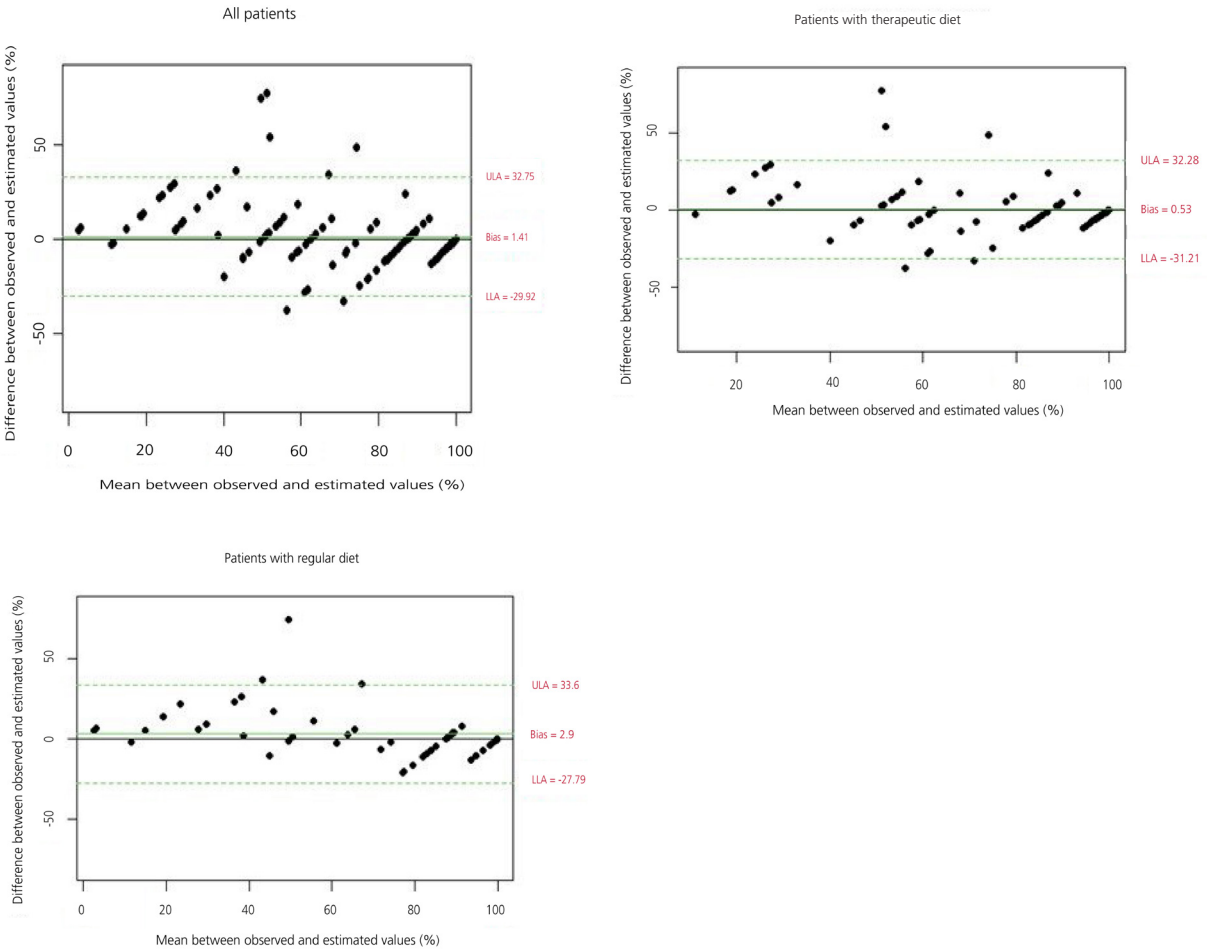

Figure 2 – Agreement analysis between patients' actual and estimated food intake.
Note: Bias: mean of the difference between actual and estimated food intake percentages; LLA: Lower Limits of Agreement (bias - 2SD); ULA: Upper Limits of Agreement (bias + 2SD).

Table 2 – Food-intake estimation accuracy analysis between regular and therapeutic diets. *Uberlândia* (MG), Brazil, 2016-2017.

Diet prescription	Underestimation		Adequate estimation		Overestimation		*p*-value[1]
	n	%	n	%	n	%	
Overall	17	11.9[a]	102	71.3[b]	24	16.8[a]	<0.0001
Regular diet	8	15.1[a]	36	67.9[b]	9	17.0[a]	<0.0001
Therapeutic diet	9	10.0[a]	66	73.3[b]	15	16.7[a]	<0.0001
p-value[2]	0.52		0.61		0.99		

Note:The same letters mean there is no difference between groups. *p*-value[1]: means that adequate estimate percentage (b) was different than underestimated (a) and overestimated (a) ones. *p*-value[2]: means that there were no diferences between estimation comparing regular and therapeutic diets in each category (under, adequate and overstimation).

Most patients recorded proper estimates based on the percentage of patients that recorded adequate food-intake estimations (estimated variation of ±10% in comparison to the actual value). According to the results, the actual food-intake percentage was the only variable associated with adequate food-intake estimation.

Table 3 – Factors associated with the accuracy of hospital patients' food-intake estimation in the univariate multinomial logistic regression. *Uberlândia* (MG), Brazil, 2016-2017.

Variables	Food intake estimation					
	Underestimation			Overestimation		
	OR	95% CI	*p*-value	OR	95% CI	*p*-value
Age	1.00	0.97-1.04	0.875	0.97	0.94-1.00	0.073
Sex (Female)	1.83	0.63-5.33	0.266	0.60	0.24-1.49	0.273
Hospitalization day (1st)	0.33	0.10-1.07	0.065	1.49	0.60-3.66	0.389
Diet prescription (Regular Diet)	1.63	0.58-4.59	0.355	1.10	0.44-2.76	0.839
Amount of served food	1.00	0.99-1.00	0.695	1.00	0.99-1.01	0.684
Actual food intake percentage	0.97	0.96-0.99	0.012	0.97	0.95-0.99	<0.001

Note: CI: Confidence Interval. OR: Odds Ratio.

Previous studies have shown good accuracy in hospital patients' visual food-intake estimates when visual instruments were adopted [26,27,29,37,38,49]. Such accuracy was also found in the current study, but there was one difference: our estimate was performed by the patients themselves using a 12.5-estimate unit 9-point scale, which is smaller than the usual ones: 4-point (25 and 50 units) [26], 5-point (25 units) [30,34,37] and 6-point (10 and 25 units) [27,38] scales. In all studies mentioned, the authors used the weighing method as the gold standard, except for Parent *et al.* [38], and the estimations were made by the clinical staff, except for Førli *et al.* [37], where they were done by the patient. Williamson *et al.* [49] and Kawasaki *et al.* [29] also used smaller scales (10 units) and found positive results through comparisons between visual estimation and the actual weight; however, both values were estimated by health professionals. Winzer *et al.* [21] and Palmer *et al.* [30] used 25-unit scales and found low accuracy and precision between the visual estimate and the actual weight, which was conducted by the patients and by untrained nursing technicians, respectively. These authors emphasized the importance of being trained to perform this task.

The smaller scales (10 units) [29,49] and the 12.5 unit 9-point scale proposed in the present study seem to be more accurate than the larger-value ones. Bartkowiak, Jones, and Bannerman [50] found that agreement limits in the 50-unit visual scale were greater than the ones in the 25-unit scale, which means that there was more variability between the actual and estimated food intake analyzed for the 50-unit scale. This data suggests that larger percentage ranges in the scales (choice between 3 to 6 points) can impair the accuracy of the estimates, probably because they could not have a number of points sufficiently close to indicate the actual food intake.

In the present study, the estimation made by the patients was related to the total amount of food, not to each component of the meal. This procedure may have improved the estimates and led to good agreement between methods. On the other hand, it might have impaired the independent evaluation of food, energy, and nutrient intake. Most studies evaluate the food-intake estimation when the food is served in partitioned trays or in specific containers, differently from the container used in our study (round foam food container without partitions) [1,21,29,51-53].

Good agreement was found between methods. Furthermore, based on the accuracy of regular and therapeutic diet estimation analyses, most patients (~70%) made good estimates of the amount of food eaten (±10% of the actual value). Accordingly, 57% of patients assessed by Winzer *et al.* [21] correctly estimated their food intake when they used the 5-point plate diagram. However, values ±25% out of the actual value were considered correct. Thus, such range increases the number of estimates categorized as adequate.

Food-intake estimate accuracy can be influenced by many factors intrinsic and extrinsic to the individual that performs the estimate. Some studies indicate that younger individuals are able to estimate with greater accuracy than elder individuals, who tend to overestimate their food intake [39,40]. On the other hand, other studies show that women estimate more precisely than men, probably due to their greater familiarity in measuring the amount of food in their daily lives [39,41,42]. The appearance of the diet and its consistency can also influence the accuracy of the food-intake estimate, since the visual appearance of the food, the way its presented, its serving size and texture, may affect the observer's ability to accurately estimate the food portions, as well as the amount of food served in a meal, since very small or large portions are more difficult to estimate accurately [40,43,44]. The length of the hospital stay can also affect the estimate, since the longer the hospital stay, the greater the amount of leftovers on the patients' plate [45]. Berrut *et al.* [36] and Ott *et al.* [54] identified that the complexity of the meal (greater food variety) can also affect the food serving estimate validity.

In our study, a higher actual food-intake percentage (or less leftovers in the plate) was the only variable associated with the accuracy of food-intake estimation (every 1% increase in food intake showed a 3% decrease in the probability of under or overestimated food intake). This outcome can be explained by the fact that the error probability was lower when smaller amounts of food needed to be estimated, since there was a lower limit (zero). Nelson *et al.* [39] found that estimate errors were reduced when smaller amounts were assessed and increased when larger amounts were evaluated. Chandon and Ordabayeva [55] called this effect "the accuracy of less"; however, they argue that this effect may disappear when a maximum limit is set for the estimate, such as for food-intake percentage estimates, which has superior limits (100%). The experiment results in the present study did not support this theory. On the other hand, other studies have shown that smaller amounts of food tend to be overestimated and larger amounts tend to be underestimated. This is called the "flat slope phenomenon" [39,56-58]. With respect to hospitals, a higher probability of under or overestimates when smaller amounts are consumed is unsettling, since it implies in errors in the daily food-intake estimate, as well as possible inadequacies in supplementary nutritional adjustments, which may impair the patients' nutritional conditions.

There are some advantages and disadvantages in relation to the instrument tested in this study. The use of smaller scales can provide a more accurate assessment of the food-intake estimate than the other scales with larger percentage ranges, since it provides more choices according to your perception of food intake [50]. Moreover, the fact that the scale be filled by the patient allows your involvement with your self-care and active participation in the therapeutic process. Thus, this instrument can contribute for more continuous monitoring of nutrition care and optimize the work routine of the healthcare professionals, which often have several attributions and are unable to assist in the nutritional monitoring of all patients. Furthermore, the use of visual scales can be easily implemented in the routine care, since it is a simpler and quicker method of assessment of food intake and can be an important tool for the early detection of the patients who need more specialized nutritional care [15].

However, this instrument also has some disadvantages. The estimation of food intake is based on an entire meal and not on each of the food items individually, which doesn't allow a more detailed analysis about the contribution in terms of energy, protein, and micronutrients of each food items in the food intake. In addition, this method may become obsolete over time due to the advent of new technologies in food service systems. Nevertheless, it is still a quick solution for estimating bedside food intake [23].

Some limitations of the present study should be taken into consideration. For one, food items were not weighed individually, impairing energy and protein-intake estimates. We chose to weigh the total

content of the meal before and after the intake, because we would not alter the portioning and food-delivery logistic at the studied hospital, where the amount of each food component in the diet provided was not standardized, implying in variability in the amount of each food component served between patients who received the same diet prescription. Unconscious and non-communicative patients were not included and only individuals from a single type of ward were evaluated; therefore, the results cannot be extrapolated for all hospitalized patients.

In conclusion, most of the evaluated patients adequately estimate their food intake. Moreover, the only factor linked to the accuracy of food-intake estimations was the actual food-intake percentage (best accuracy when there were less leftovers in the plate). These findings provide preliminary support for the usefulness of this instrument in which the patients' self-monitor their food intake. Accordingly, the daily assessment of in-hospital food intake can be improved when the responsibility of self-care and dietary self-monitoring is transferred to the patients themselves. However, this is a pilot study, and it must be tested in a representative sample of hospitalized patients, from different wards, to confirm the findings.

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CONTRIBUTORS

CC JAPUR contributed to the conception and design of the research; FRO PENAFORTE contributed to the design of the research; YG AMARAL contributed to the acquisition and analysis of the data; LB ARAÚJO contributed to the analysis of the data; YG AMARAL and CC JAPUR contributed to the interpretation of the data and drafted the manuscript. All authors critically revised the manuscript, agreed to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

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