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AGREEMENT BETWEEN BODY MASS INDEX, CALF CIRCUMFERENCE, ARM CIRCUMFERENCE, HABITUAL ENERGY INTAKE AND THE MNA IN HOSPITALIZED ELDERLY

V. APARECIDA LEANDRO-MERHI[1], J. LUIZ BRAGA DE AQUINO[2], J. GONZAGA TEIXEIRA DE CAMARGO[2]

Pontifical Catholic University of Campinas (PUC-Campinas), SP-BrazilSchool of Nutrition and Medicine, 1. Prof. Dr. of the School of Nutrition, Puc-Campinas-SP-Brazil; 2. Prof. Dr. of the School of Medicine, Puc-Campinas-SP-Brazil. Address correspondence to: Vânia Ap. Leandro-Merhi, Av. Carlos Grimaldi, 1171, Quadra D-13, Bairro: Jardim Madalena, Residencial Vila Verde, Cep.:- 13091-906- Campinas-SP-Brazil, 55-19-7808-5990, e-mail: valm@dglnet.com.br

Abstract: *Objectives:* This study aimed to assess the agreement between body mass index, calf circumference, arm circumference, habitual energy intake and the mini nutritional assessment (MNA) and then assess the accuracy of these parameters in relation to the MNA. *Method:* The nutritional status of 132 hospitalized elderly was assessed with the MNA, body mass index (BMI), calf circumference (CC) and arm circumference (AC). Their habitual energy intake (HEI) was also determined. The chi-square and the Mann-Whitney tests were used. The agreement between the nutritional risk criteria and the MNA was determined by the Kappa coefficient. The ROC curve was used to determine the accuracy of the parameters in relation to the MNA and to determine the cut-off values. The significance level was set at 5% ($p<0.05$). *Results:* A little more than half the sample (54.5%) was well nourished, 34.9% were at risk of malnutrition and 10.6% were malnourished. There was good agreement only for BMI<22 (Kappa=0.44), with an accuracy (AUC) of 0.78. No agreement was found for the other parameters, their sensitivities were shown to be low. However, CC and AC were very specific for determining the well nourished patients: the CC specificity was 86.1% and AC specificity was 94.4%. The cut-off values determined by the ROC curve were ≤23.2 for BMI, ≤26.2 for AC and ≤32.2 for CC. *Conclusion:* The best parameters to determine nutritional risk in relation to the MNA were AC, BMI and CC. However, these nutritional assessment parameters should be used to replace the MNA for the assessment of hospitalized elderly patients with their current cut-off points.

Key words: Nutritional risk, MNA, kappa coefficient, ROC curve, nutritional status.

Introduction

Malnutrition in the geriatric population is already a well known syndrome routinely diagnosed around the time of hospital admission. It is also associated with serious health problems and bad prognoses (1-4), showing a positive correlation with some geriatric syndromes (5). However, malnutrition or problems related to malnutrition in the elderly are still rarely recognized and treated in the hospital setting (6). Either way, it is essential for all elderly patients to undergo nutritional assessment at hospital admission. The Mini Nutritional Assessment (MNA) is a screening tool developed for detecting malnutrition or risk of malnutrition. It is considered a good standard for determining the nutritional status of the elderly. The nutritional status of patients can be easily determined with a few questions and anthropometric measurements, regardless of laboratory tests (7-9).

Since different nutritional assessment parameters result in different prevalences of malnutrition in the elderly, it is critical to compare these parameters with the MNA, since the MNA is considered a good predictor of the functional status of institutionalized elderly patients at risk of malnutrition (10) and is recommended by the European Society for Clinical Nutrition and Metabolism (ESPEN) for the routine nutritional assessment of geriatric patients (11).

Thus, the objective of the present study was to assess the agreement between different nutritional assessment parameters and the MNA and then verify the accuracy of these parameters in relation to the MNA in hospitalized patients.

Casuistic and Method

Study design

This study was done in 2009 with 132 elderly patients of both genders (59.8% males and 40.2% females) hospitalized in the surgery ward of the Hospital e Maternidade Celso Pierro of the Pontifical Catholic University of Campinas, state of São Paulo, Brazil. The study began after approval from the administration of the hospital and the local Research Ethics Committee, protocol number 925/08. At first, 200 patients were selected to take part in the study, who met the inclusion criteria. After the initial screening, on the first week of data collection, 68 patients refused to participate in the study. Thus, 132 patients or the people responsible for them signed a free and informed consent form.

The inclusion criteria were: age ≥ 60 years, having undergone nutritional assessment within 48 hours of hospital admission, not being in the terminal stage of a disease, and medical records containing information on the nutritional status, disease and length of hospital stay (LHS). The exclusion criteria were: medical records with incomplete nutritional status information, not having undergone nutritional status assessment

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shortly after hospital admission, patients admitted only for clinical investigations and tests, and those suffering from edema or ascites (which would lead to a misleading interpretation of the anthropometric data). The definition of elderly was taken from the National Policy for the Elderly, which defines any individual aged 60 years or older as elderly (12).

The nutritional status of the patients was assessed shortly after hospital admission (on their first day of hospitalization), by the very researchers responsible for the project, by the following parameters: anthropometric indicators, habitual energy intake (HEI) and the mini nutritional assessment (MNA).

Anthropometric indicators

Current weight (CW), height (H), arm circumference (AC) and calf circumference (CC) were measured. Body mass index was calculated by dividing the weight by the square of the height (weight/height^2) and classified according to the criteria established by Lipschitz (1994) (13), who suggested the following cut-off points for the elderly: underweight (malnourished) when BMI≤22, well nourished when 22<BMI<27 and overweight when BMI≥27. AC was classified according to the criteria proposed by Frisancho (14) for individuals younger than 65 years of age and by Burr and Phillips for individuals older than 65 years of age (15). The CC was classified according to the cut-off point established for the elderly, which is of 31 cm (16). The cut-off points for BMI, AC and CC were suitable for the study population and the specific age range.

Study of dental problems

The presence or absence of dental problems, such as missing teeth and prostheses, which could influence the nutritional status, were also investigated.

Determination of the habitual energy intake (HEI)

Dietary recall questionnaires were administered to the studied population at hospital admission (which refers to the home energy intake, in the period of time immediately before the first day of hospital admission, showing the standard food consumption), allowing the determination of the habitual energy intake. This energy intake was assessed using a 24-hour recall. For the sake of accuracy, participants were asked what foods they ate and at what times, how the foods were prepared, amounts in portions, and product brands. The questionnaire also included other questions such as the amount of oil, sugar, and salt used monthly; amount of liquids ingested daily; number of people per household; and use of dietary supplements. The dietary data obtained in cooking units were converted to grams and milliliters in order to analyze nutrient intake. The centesimal composition of the foods listed in the 24-hour recalls was then calculated by the NutWin® (2002) (17) software, version 1.5. The foods that were not listed in the abovementioned software were added from food composition tables and labels (18-20). The macronutrient percentages of the diet were compared with the dietary recommendations proposed by the Food and Nutrition Board (2002) (21).

The percentage of the caloric adequacy of the habitual energy intake in relation to the energy requirement was then calculated (%HEI/ER). The energy requirement (ER) represents the total energy expenditure of the individual. ER was determined by the Harris-Benedict equation (22).

Mini nutritional assessment (MNA)

The MNA was administered as recommended by Guigoz et al, 1994 (7). The MNA includes questions regarding weight change, dietary change, gastrointestinal symptoms, mobility, physical assessment and disease and its relationship with nutritional requirement 7. The MNA consists of 18 questions and a maximum score of 30 points. Patients that score ≥24 points are considered well nourished, those that score 17-23.5 points are at risk of malnourishment and those that score <17 points are malnourished.

Criteria for assessing nutritional risk

After nutritional assessments were done with the abovementioned parameters, nutritional risk criteria were adopted in the present study, as follows: BMI below 22 kg/m^2 (BMI<22), CC below 31 cm (CC<31), AC below the 10th percentile, characterized by reference standard from Burr & Phillips, 1984 (15) (AC<P10) e adequacy of energy intake below 75% (HEI/ER<75%).

Statistical analysis

At first, the studied variables were analyzed descriptively by calculating the means, standard deviations and proportions. Associations were determined by the chi-square test and the comparison of the continuous and ordinal variables between two groups was done by the Mann-Whitney test.

The Kappa coefficient (23) was used to verify the agreement among the nutritional risk parameters. The magnitude of this coefficient was defined as follows: values between 0.75 and 0.40 indicate good agreement and values below or equal to 0.40 do not indicate agreement.

The accuracy of the nutritional assessment parameters in relation to the MNA and the cut-off points were determined by the receiver operator characteristic (ROC) curve (24). This curve expresses the relationship between sensitivity and specificity in a given test. The sensitivity of the model was defined as the percentage of malnourished elderly that were correctly identified by the test. Alternatively, the specificity of the model was defined by the percentage of non-malnourished elderly that were correctly identified. The accuracy of the parameters was defined as the area under the curve (AUC). The significance level adopted for the statistical tests was 5% ($p<0.05$). The software SAS and SPSS were used for the statistical analyses (25, 26).

Results

Of the 132 studied patients, 79 (59.8%) were males and 53 (40.2%) were females; 45.5% of them were in the 60-69 years age range, 36.3% were in the 70 to 79 years age range and 18.2% were in the 80 to 91 years age range. Ninety-six (72.7%) of them had benign diseases and 36 (27.3%) had malignant diseases. The mean age of the sample was 71.7±8.2 years; the mean BMI was 24.5±6.1 kg/m^2 (median: 20 kg/m^2); mean CC was 32.7±4.4 cm; mean AC was 28.2±5.0 cm; the mean percentage of adequacy of HEI/ER was 71.6±29.9% and the mean length of hospital stay was 6.5±6.6 days.

Table 1 shows the presence or absence of nutritional risk according to the studied parameters. According to the BMI, CC and AC, 35.6%, 26.2% and 15.9%, respectively, were at nutritional risk; 60.9% presented a HEI below 75% of their energy requirement. According to the MNA, 72 (54.5%) of the patients were well nourished, 46 (34.9%) were at risk of malnutrition and 14 (10.6%) were malnourished. If the patients at risk of malnourishment and the malnourished patients are grouped together, a total of 60 (45.5%) patients were at risk of malnourishment according to the MNA.

Table 1
Nutritional risk in the studied population according to the different nutritional assessment parameters

Variables	Nutritional Risk YES N (%)	NO N (%)	TOTAL N
Body mass index <22 kg/m^2	41 (35.6)	74 (64.4)	115
Calf circumference <31 cm	34 (26.2)	96 (73.8)	130
Arm circumference < P10	21 (15.9)	111 (84.1)	132
HEI/ER <75%*	78 (60.9)	50 (39.1)	128

*HEI/ER<75%: % of the habitual energy intake in relation to the energy requirement below 75%.

Since many (n=89, 67.4%) of the elderly in this sample presented dental problems such as missing teeth, prostheses, among other problems, we investigated if these dental problems determined nutritional risk. Not one of the nutritional assessment parameters studied (BMI, CC, AC, %HEI/ER and MNA) were associated with dental problems. In relation to the MNA, the sensitivity was 44.94% and the specificity 53.49%.

Table 2 shows the agreement and accuracy between nutritional risk assessment parameters and the MNA in the elderly. Only BMI<22 presents good agreement (Kappa coefficient = 0.44), with an accuracy (AUC) of 0.78. The other parameters did not present good agreement or sensitivity. However, CC and AC were both very specific for detecting well nourished patients (for CC the specificity was 86.1% and for AC it was 94.4%).

Figure 1 shows the ROC curve being used to determine the cut-off points of the anthropometric parameters and energy intake. The cut-off points will identify the elderly at nutritional risk. AC, BMI and CC had a similar accuracy for determining nutritional risk. The %HEI/ER was not a satisfactory indicator of nutritional risk in relation to the MNA. The cut-off points determined by the ROC curve in the present study were ≤23.2 for BMI; ≤26.2 for AC and ≤32.2 for CC.

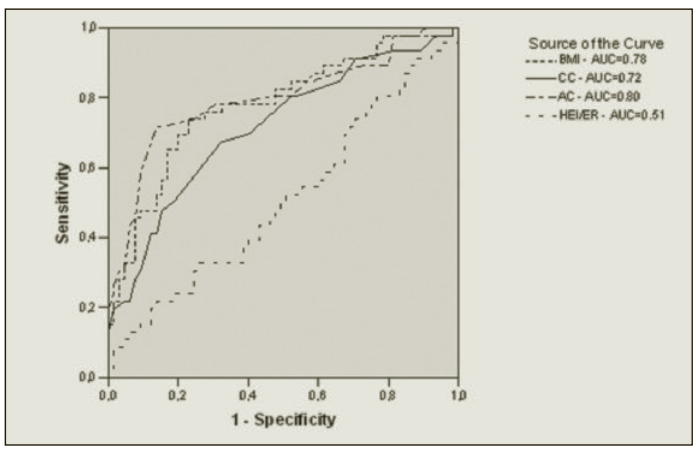
Table 2
Agreement and accuracy of nutritional risk assessment parameters in the studied population in relation to the MNA

Variables	M + RM (MNA) Sensitivity	** Well nourished (MNA) Specificity	AUC***	Kappa
Body mass index <22 kg/m^2	30/50 (60.0%)	54/65 (83.1%)	0.78	0.44
Calf circumference <31 cm	24/58 (41.4%)	62/72 (86.1%)	0.72	0.29
Arm circumference < P10	17/60 (28.3%)	68/72 (94.4%)	0.80	0.24
HEI/ER <75%*	32/56 (57.1%)	26/72 (36.1%)	0.51	-0.06

* HEI/ER<75%: % of the habitual energy intake in relation to the energy requirement below 75%; ** M + RM: group of malnourished patients plus those at risk of malnourishment according to the MNA; ***AUC: accuracy (area under the curve).

If the BMI, AC and CC cut-off values were changed to those obtained by the ROC curve (≤23.2; ≤26.2; and ≤32.2 respectively) for this particular sample, there would be an increase in the sensitivities (73.9% for BMI, 71.7% for AC and 67.3% for CC) and specificities (76.9% for BMI, 86.1% for AC and 67.7% for CC) for identifying nutritional risk.

Figure 1
ROC curves of the anthropometric parameters and energy intake for identifying nutritional risk in elderly assessed by the MNA



Discussion

The elderly population has been growing substantially in many industrialized countries and malnutrition has been pointed out as an important clinical situation in hospitalized elderly. The estimated prevalences of malnutrition specifically

among the elderly have been reported in many studies around the world. Saka et al. (2010) reports 44% (5), Amaral et al. (2010) reports 45.7% (27) and Oliveira et al. (2009) reports 66.2% (1) when the population at risk of malnutrition is added to the malnourished population.

The present study clearly documents the different nutritional status diagnoses obtained by different parameters and the MNA. This is also seen in other studies that use different nutritional assessment instruments (6). Could it be that the MNA was more sensitive to identify the malnourished population in this study (if we add the malnourished to those at risk of malnourishment)?

In a recent study, Filipovic et al., 2010 (28), compared nutritional assessment methods in 299 patients and found 45.7% and 63.9% to be malnourished to some extent according to the SGA and NRI respectively. In another multicentric study, Amaral et al., 2010 (27), found 36% of the patients to be at risk of malnourishment according to the NRS and 9.7% to be malnourished according to anthropometry. Earlier studies done in European hospitals have shown a prevalence of 10 to 50%, depending on the group of studied patients (29). Recently, a study involving hospitalized patients in Turkey (29) found 15% of the patients to be at risk of malnourishment. Other recent studies have also reported prevalences ranging from 30 to 50% (31-33). This evidences the different malnutrition prevalence rates found by different studies using different instruments. This situation implies on the need of using many nutritional assessment parameters when attempting to diagnose hospital malnutrition. However, another study that investigated the accuracy of traditional nutritional assessment parameters found that the nutritional assessment methods employed were weak predictive factors of clinical outcomes, death, infection and length of hospital stay (34).

Recent studies of hospitalized elderly patients have reported a mean BMI value of 25.1±4.4 kg/m^2 (6) and a median smaller than 20 kg/m^2 in part of the studied population (5). The other parameters that were used to determine nutritional risk in this study found different malnutrition prevalences. The different prevalences of malnutrition document the discrepancies among the different nutritional assessment parameters. Different methods were used in this study to determine the prevalences of malnutrition in hospitalized elderly because they focus on different aspects of nutritional status and because a universal consensus of which method is best is still inexistent. Thus, the use of more than one method or parameter may detect malnutrition better than using only one method.

When the agreement and accuracy of the nutritional indicators in relation to the MNA were assessed, only BMI proved to have a good agreement (kappa=0.44 and accuracy of 0.78). The sensitivity for identifying malnutrition (M+RM) regarding the BMI and MNA occurred in 60% of the patients. Sensitivity assessment was crucial for determining which parameter best identified the malnourished individuals. Specificity assessment was important to identify the well nourished individuals that could be incorrectly diagnosed as malnourished. Among the assessed parameters (BMI, arm circumference, calf circumference and energy intake) using the reference cut-off points, only BMI presented a moderate agreement with the MNA for the classification of individuals at nutritional risk. These anthropometric indicators presented high specificity and very low sensitivity.

In spite of the ROC curve, the purpose of this study was not to discuss or establish new cut-off points for the anthropometric indicators, nor was it our intention to explore such data, which have been extensively studied and established in the pertinent literature (13-16). In this study, the aim was to investigate only the nutritional status of the elderly population, and explore the agreement of some parameters already used in Brazil in the assessment of hospitalized elderly, with the MNA.

The data assessed in the present work show that the indicators other than the BMI presented low sensitivity. However, AC and CC were much more specific for the detection of well nourished individuals. HEI/ER<75% did not prove to be a good indicator in this population. It presented low sensitivity and specificity. However, in other studies, reduced energy intake has been strongly associated with the MNA (35), as well as weight loss, psychological stress and AC. It is important to emphasize that one of the main causes for low food intake can be associated with dental and gastrointestinal changes, which contribute to further compromise the nutritional status of the elderly. Literature states that an elderly person with dental problems is 3.7 times more likely to have an inadequate energy intake and 42.0 times more likely to become underweight (36).

The prevalence of malnutrition found among the participants of this study was similar to that of other published studies and only BMI had a good agreement with the MNA. The sensitivity and specificity determined by the ROC curve showed that the best parameters were AC (0.80), BMI (0.78) and CC (0.72) for determining nutritional risk in relation to the MNA. It is worth pointing out that if the cut-off points were increased, the sensitivity and specificity of the studied parameters would have increased significantly, that is, more that 70% for AC and for BMI.

Since the MNA involves other issues besides the anthropometric parameters, the respective weights attributed to these parameters end up dispersed over other questions approaches in the MNA questionnaire. It is important to point out that the present study was conducted in hospitalized patients and patients with normal BMI can be often found, but with other MNA questionnaire indicators compromised.

Therefore, the weight of the questionnaire parameters should not be taken into account as this does not compromise the reliability of the results. For instance, the weight loss in the previous three months also has weight 3, and the patient may present weight loss, but not necessarily a compromised BMI (in hospitalized patients).

Limiting factors

This study attempted to compare the predictive ability of single anthropometric parameters (BMI, AC and CC) and habitual energy intake with nutritional scores assessed with the MNA scale. Our study suffers from several limitations. The study examined a selected population of hospitalized elderly patients with and without risk for malnutrition, however this was a single study with a relatively small convenience sample. In addition, the study is a cross-sectional survey and thus cannot serve to determine temporal relationships.

Limitation to the study is the achievement of data only from patients admitted to our hospital. Further investigations from different hospitals are needed for confirmation of the data.

Conclusion

In conclusion, the best parameters to determine nutritional risk in relation to the MNA were AC, BMI and CC. However, these nutritional assessment parameters should be used to replace the MNA for the assessment of hospitalized elderly patients with their current cut-off points.

Competing Interest: The authors declare that they have no competing interests.

Authors Contributions: -Vania Aparecida Leandro Merhi was involved in the protocol and study design, analysis, carried out the statistical analysis, writing of the article and critically reviewed the article. - José Luiz Braga de Aquino and José Gonzaga Teixeira de Camargo was involved in the study design and critically reviewed the article. The authors read and approved the final manuscript.

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