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NEW VALUES ANTHROPOMETRY FOR CLASSIFICATION OF NUTRITIONAL STATUS IN THE ELDERLY

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Abstract: Anthropometry provides information on the physical status of the individual and can be associated with aspects of health including nutritional status. Currently, the stratification of the arm and calf circumferences is classified into only two situations: "malnourished" and "well-nourished". A total of 513 interviews were conducted, and 391 elderly people (≥65 years) completed the assessment using the Mini Nutritional Assessment (MNA) and anthropometry of selected samples of the population of Cuiabá-MT. The body mass index (BMI, kg/m2) was calculated for the elderly people, establishing five new reference values for circumferences, arm relaxed (RAC), abdomen (AC), and calf (CC) in centimeters (cm). The median age was 71 years (64% women and 36% men) and was correlated to the RAC (r=-0.180, p<0.001) and CC (r=-0.202, p<0.001). The BMI obtained the median of 27 (15% malnourished, risk of malnutrition 13%, eutrophic 24%; overweight 33%, obese 16%), and it was correlated to the RAC (r=0.798, p<0.001), AC (r=0.823 p <0.001) and CC (r=0.605, p<0.001). The MNA was 26 (malnourished 13.8%, risk of malnutrition 12.3%, well-nourished, 73.9%). The BMI stratification by morbidity vs no morbidity was 27.50 (n=287) and 24.4 (n=104) to total sample respectively (p<0,05). The RAC x AC (r=0.798, p<0.001), RAC x CC (r=0.648, p<0.001), and CC x AC (r=0.496, p<0.001) were correlated between themselves. The eutrophic classification by circumference for both genders: RAC=27.1-29.00 cm, AC=88.1-95.00 cm, CC=32.60-33.00 cm. There are more overweight and obese than malnourished, which is a risk factor for morbidity and MNA only identifies malnutrition. Circumferences showed good association with BMI and are easy to apply. Therefore, the proposal of the circumferences can simplify and expand the nutritional assessment.

Key words: Nutritional status, body mass index, anthropometry, elderly.

Introduction

The nutritional assessment can detect a state of malnutrition, overweight and obesity early in the elderly (1, 2). Extreme situations of nutritional status are worrying(1) and generate costs for the healthcare systems (3, 4). A delay in the nutritional diagnosis can result in health hazards and lead to premature death (5).

Anthropometry (6) is a rapid and useful method to evaluate the biotype and consequently, provide information on the physical status of the individual. This type of evaluation can be associated with health issues, including the nutritional status (6). Dietary habits associated with lifestyle, indicate a chronic situation, and the imbalance between calorie intake and energy expenditure results in classifications of underweight (malnutrition) or overweight (obesity) (1, 2).

In the current literature, the stratification of arm and calf circumferences (7, 8), are classified into only two different situations: "malnourished" and "well-nourished". Furthermore, there is no identification of which abdomen circumference values are equivalent to the values of overweight and obese. Therefore, to establish this stratified information into five categories would provide a more accurate evaluation and an easier way to predict the nutritional status. In addition, the World Health Organization-WHO Physical Status (6), recommends that each country should establish the anthropometric values and indexes that best fit their population, taking into consideration: race, biotype, gender, culture, and age. It is not yet consensus on the appropriate cutoff point of BMI(6) for the elderly. The researchers show that being overweight can be a protective factor for mortality when compared elderly underweight (9). The circumferences proposed here could an alternative on this subject.

The aims of this study were to evaluate to describe and compare the nutritional status using different instruments to establish five new categories of nutritional status for three circumferences in elderly people over 65 years of age of the both genders.

Methods

This is a population-based, cross-sectional, census study, conducted from 2009 to 2010, with elderly people 65 years of age or more, of both genders. The subjects were all residents in the urban area of Cuiabá-MT, located in the Midwest region of Brazil. All the subjects signed the terms of free prior informed consent, and the study was approved by the Research Ethics Committee of the Julio Muller Hospital (HUJM, 632/09).

The sample consisted of 391 elderly people. To perform this calculation, the distribution of the 117(one hundred and

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seventeen) census regions (CR) of the city (10) was used as a basis, with 15 (fifteen) selected from these. The proportion of elderly was calculated for each census tract in relation to the total elderly population in the city. The density of elderly per household by dividing the number of elderly people by the number of existing households was calculated in each census tract. The following was divided the number of elderly calculated density (census sector) by the number of households to be visited. Maps provided by the Brazilian Institute of Geography and Statistics-IBGE (10) were counted, the randomly selected blocks and identified homes for visits. The CRs included 120,368 households and 17,329 elderly people, that was used to sample (11, 12) expression [1]:

$$n = \frac{z_{\alpha}^2 p(1-p)}{E^2} \quad [1]$$

Those individuals who did not complete all the stages of the evaluation, were residents in long-stay institutions (LSIs), who obtained less than 19 points in the mini mental state examination (MMSE) (13, 14), were wheelchair users or bedridden, who presented severe stroke sequel, acute hepathomegaly, acute ascites, severe lymphedema, anasarcas, or Parkinson's disease in advanced stages, were terminally ill or had any kind of cancer of all forms, except skin cancer, were excluded.

The interviews were performed in the residence of the elderly people on weekdays, by trained interviewers after pilot collection and standardization of the assessment techniques. All the instruments used were previously tested with another population of elderly people in order to correct possible mistakes. Using a form, the elderly people answered questions related to sociodemographic characteristics, reported diseases, and lifestyle (10). Among the socio-demographic variables, age was obtained in complete years and classified according to Spirduso (15). Questions were asked regarding the existence of hypertension (HBP) or diabetes mellitus (DM) comorbidities, and about the frequency of visits to the physician and hospitalizations during the year. In this interview the MMSE (13, 14) and the Mini Nutritional Assessment (MNA)(7) were applied.

Anthropometry

Anthropometric measurements were performed on Saturdays, in the morning, by one trained evaluator. All the measurements were performed in duplicate, and the means were calculated for analysis. Body weight in kg was measured on digital platform scales (model G-Tech® Glass 3S, 180 kg, accuracy of 0.05 kg). Height was measured with a metric Starrett®-3m rigid measuring tape with accuracy of 0.5 centimeters (cm), in orthostatic position and with the elderly people wearing few clothes and without shoes (16). The BMI (kg/m2) was calculated from the Nutritional Screening Initiative (NSI) (17, 18), and the following values were used as references: for malnutrition <22, risk of malnutrition 22-23, eutrophic 24-27, overweight 27-32 and obesity >32 for both genders.

Circumferences were measured using a measuring tape, with the elderly people standing in the right hemisphere. The arm circumference (RAC) was measured in centimeters (cm) at the midpoint between the acromion and the olecranon with the arm extended, muscles relaxed and with the palm of the hand facing the thigh. The elderly people were classified as malnourished when the RAC was less than 24 cm, and well-nourished when higher. The calf circumference (CC) was measured with the elderly people standing, at the greatest circumference. Values less than 31 cm were classified as malnourished and values equal to or over 31cm as well-nourished for both men and women(7,19,8). The abdominal circumference (AC) was measured in the end-expiratory phase of breathing (20), below the umbilical scar(21).

Statistical Analysis

There was a non-normal distribution of variables according to the Shapiro Wilk Test. The internal consistency of the data was tested with Cronbach's alpha coefficient and was found to be adequate (α>0.607)(22). The inferential analysis of the continuous data among the variables was performed with Spearman´s correlation and the following relationship values were considered: 0 to 0.39=weak relationship, 0.40 to 0.69=moderate relationship, and from 0.70 to 1.00=strong relationship (23). The Mann-Whitney test was used for comparisons of up to two categories per variable. When there were more than two categories, the Kruskal-Wallis test was used to verify whether there was any difference between the medians. Thus, to test the significance of the k(k-1)/2 individual pairs of differences, nonparametric multiple comparisons were made as follows(24):

$$H_{ij}^{*} = z_{\alpha/(k(k-1))}\sqrt{\frac{n(n+1)}{12}\left(\frac{1}{n_i}+\frac{1}{n_j}\right)} \quad [2]$$

where n is the sample size per variable and ni and nj the sample size per compared categories. Therefore, if, that is, if the difference of the medium points ( ) of the categories tested is higher than the critical value it is concluded that the medians are different. To establish the nutritional status by anthropometry, the reference values for CC, RAC, AC were calculated using the BMI-NSI as a comparative basis for risk of malnutrition, normal weight, overweight and obesity of these elderly people. In all tests, statistical significance was p(≤0.05). The statistical package used was the Statistical Package for the Social Sciences (SPSS ®) version 15.0 for Windows.

Results

A total of 513 elderly people were interviewed, with 122 (23.78%) losses for the following reasons: dropouts from the

Table 1
Characterization of the elderly people according to sociodemographic variables and nutritional status

Variables		n (391)	Percentage (%)
Gender	Man	142	36.3
	Woman	249	63.7
Age group	65 to 74 years	266	68.0
	75 to 84 years	108	27.6
	≥85 years	17	4.3
BMI-NSI (kg/m2)	Malnourished (< 22)	60	15.3
	Risk of malnutrition (22 to 23)	49	12.6
	Eutrophic (24 to 27)	92	23.5
	Overweigh (27 to 32)	129	33.0
	Obese (> 32)	61	15.7
Calf circumference (CC) cm	Malnourished < 31 cm	72	18.4
	Well-nourished > 31 cm	319	81.6
Arm circumference RAC cm	Malnourished < 24 cm	18	4.6
	Well-nourished > 24 cm	371	94.9
Mini Nutritional Assessment (MNA)	Malnourished < 17 points	54	13.8
	Risk of malnutrition 17 to 23.5 points	48	12.3
	Well-nourished 24 to 30 points	289	73.9

Statistical reliability by Cronbach's alpha = 0.607; NSI-BMI = body mass index proposed for the elderly from the Nutritional Screening Initiative

Table 2
Characterization of the nutritional status of the elderly people according to gender with different instruments

Variables	Total (n=391)		Man (n= 142)		Woman (n= 249)	
	Median	Min-Max	Median	Min-Max	Median	Min-Max
Age	71.0	65.00-93.00	71.5	65.00-93.00	71.0	65.00-90.00
BMI (kg/m^2)	27.0	15.10-41.90	26.1	15.10-41.90	27.3*	15.10-41.90
Arm circumference	30.0	19.00-49.00	29.5	21.00-38.70	30.0*	19.00-49.00
Calf circumference	33.5	23.50-49.50	34.5	25.50-45.00	33.0*	23.50-49.50
MNA	26.0	10.50-30.00	25.5	17.50-30.00	26.0	10.50-30.00

* p≤0.05 significant difference between genders using the Mann Whitney Test, Min = minimum, Max = maximum. RAC = arm circumference, CC = calf circumference, MNA = mini nutritional assessment, BMI = Body Mass Index.

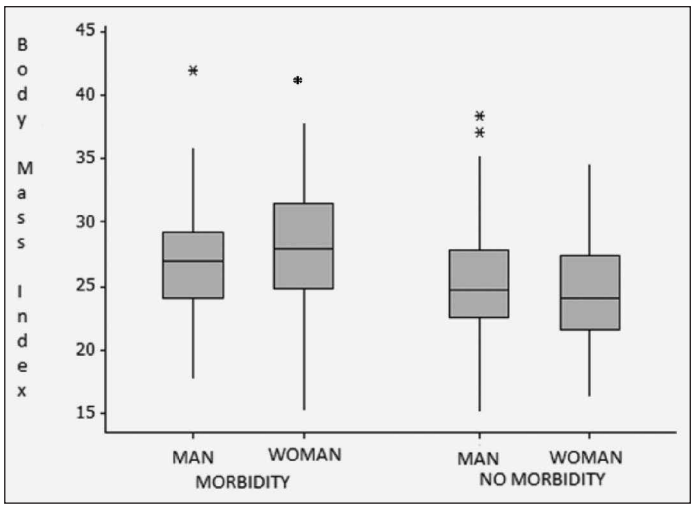
physical evaluation (n=94), due to the MMSE criterion selection option (n=20) and due to other criteria (n=08). Therefore, 391 elderly completed all the steps of the protocol. These subjects were aged between 65 and 93 years, with the majority (68%) in the age group of 65 to 74 years. According to the assessment of nutritional status using the BMI, there was a higher frequency of overweight people (33%), followed by those of normal weight (23.5%). Furthermore, the RAC, CC, and MNA classified the majority of the adults as "well-nourished" (94.9%, 81.6%, 73.9%, respectively, table 1).

The BMI median was higher in females compared to males with a significant difference (p=0.019). The median score for AC and MNA did not differ between the genders (table 2).

For the BMI and comorbidity the self-report of hypertension and diabetes was considered, verified through the use of drugs, which presented statistical significance when compared to the elderly people without comorbidities. In elderly with morbidity (n=287) overall median BMI was 27.50 and 27.00 in man and 27.90 in woman older. In elderly with no morbidity (n=104) the median BMI was 24.40 and 24.70 in man and 24.30 in woman (Figure1).

The MNA did not show a significant correlation with any variable, and there was no statistical difference when the MNA score was stratified by age (p>0.05). Age was negatively correlated with both CC and RAC and had no significance for the other variables. The BMI correlated positively with all circumference measurements; however, this correlation was strong for AC and RAC and moderate for CC. All the circumference measurements correlated positively and moderately between themselves (table 3).

Figure 1
Box plot Box plot comparing BMI by gender and comorbidity



*p≤0.05 significant between having or not having comorbidities, ** p≤0.05 significant difference between genders.

The reference values were calculated for the CC, RAC, and AC, using the BMI-NSI as the comparative basis to establish the nutritional status from the anthropometric data. The median values, given in centimeters (cm), of the circumference measurements of the CC, RAC, and AC are suggested to assess the nutritional status in the elderly of both genders. For the multiple comparison of these medians, the Kruskal Wallis test was used, through expression 2, in which the value of Za/(k(k-1))=2.80703 where α=0.05 and k=5, these comparisons are presented in the last column of table 4.

Discussion

Unlike the census of Mato Grosso (10), but similar to other studies (2, 3), we also observed a higher prevalence of woman in this sample. The median BMI for the entire sample was within the normal range for the classification of the BMI-NSI was significantly higher in woman. Were estimated at around 28% as malnourished or undernourished, 24% were eutrophic and 49% were overweight or obesity. The vast majority were classified as well nourished by circumferences and MNA. The majority of the sample had some morbidity and BMI in this group although it was close to normal was significantly higher than the group without comorbidities. A MNA was not sensitive to association with other variables. But anthropometric measurements showed a negative relationship with age and were associated with each other.

According to WHO (6) recommendations, the research sample was made up of subjects from an urban population with biotypes resulting in the mixing of cultures and races of white, black and Indian people. Two classifications are usually adopted in the literature: malnourished and well-nourished regarding arm and calf circumference (7) and normal or with a health risk from being overweight regarding the abdomen circumference (25), however, other nutritional status values had not been calculated. Concerning the AC no significant difference was observed between the genders in this study. This result is contrary to other studies (26, 27), where elderly woman presented higher levels in this variable; however, these measurements were made at different locations of the abdomen when compared with this study. Conversely, the BMI scores showed similar results to those of other studies (26, 27), which found a statistical difference in the comparison between males and females. In a five year follow-up study(28), a greater association with mortality in elderly women classified by the BMI as malnourished and with an AC less than 97 cm was found. Although the present study is cross-sectional, apparently, this trend of the AC value is repeated, as all the anthropometric measurements related to the malnourished assessment were negatively associated with age. This suggests that some degree of being overweight does not appear to affect life expectancy in this population, similar to that observed in the study by Strandberg´s(29). However, in this study the group who had comorbidities had a significantly higher BMI. However, we not analysed the comorbidities related to the deficit in weight, done in the study of Ferra et al(30), this being a limitation in this study.

The AC is considered the anthropometric measurement most highly correlated with visceral fat(31), which under normal conditions correlates well with the BMI, except in cases of acute liver disease, anasarcas and abdominal ascite (32). This was measured rigorously in the end-expiratory phase of

Table 3
Coefficient of correlation between age and anthropometric variables in the elderly people

Variable	Age (rs)	BMI-NSI (rs)	Calf Circ (rs)	#Arm Circ (rs)
MNA Score	0.011			
BMI (n=391)	-0.098			
Calf Circ (n=391)	-0.202*	0.605*		
Abdomen (n=391)	-0.025	0.823*	0.496*	
Arm Circ (n=389)	-0.180*	0.798*	0.648*	0.679*

(rs) = Spearman correlation, * p-value for significance test with p ≤ 0.05; MNA = Mini nutritional assessment, BMI = body mass index, NSI=of the Nutritional Screening Initiative, Circ = circumference, #RAC = relaxed arm circumference.

Table 4
Classification of nutritional status of the elderly people according to the cutoff points of the CC, the RAC, of the AC using the BMI-NSI categorized as reference

Variables Anthropometry	N	Median cm	Median Post (Ave Rank)	K	p-value	Comparisons
CC (cm)				137.57	<0.001	
a-Malnourished	60	30.50	87.60			c, d, e
b-Risk of malnutrition	49	32.50	146.90			d, e
c-Eutrophic	92	33.00	167.70			d, e
d-Overweight	130	35.00	236.70			e
e- Obese	60	37.25	299.70			
Total	391		196.00			
RAC (cm)				240.24	<0.001	
a- Malnourished	60	26.00	64.90			c, d, e
b- Risk of malnutrition	49	27.00	104.80			c, d, e
c- Eutrophic	92	29.00	162.00			d, e
d-Overweight	128	31.00	249.60			e
e- Obese	60	35.00	333.00			
Total	389		195.00			
AC (cm)				250.48	<0.001	
a- Malnourished	60	82.75	55.80			c, d, e
b- Risk of malnutrition	49	88.00	96.00			c, d, e
c- Eutrophic	92	95.00	174.00			d, e
d- Overweight	130	102.00	252.30			e
e- Obese	60	111.50	329.70			
Total	391		196.00			

The letters a, b, c, d and e are notes used for the comparisons of the categories of each variable; Kruskal-Wallis test, with significance level less than or equal to 0.05 ($p \leq 0.05$); As a and b have already been compared, there was no need to repeat the comparison of b with a again, and so on.

breathing (20), with the tape encompassing the abdomen in the transverse plane of the larger perimeter under the umbilical scar (21). This pattern is not always observed by all researchers. There are few studies with reference values regarding nutritional status or risk for diseases for comparison of these circumferences in the literature(28). As this categorization did not identify situations of being overweight and obese, the values in cm for these strata were calculated. In this study there was a strong correlation between the BMI and the AC, as shown in table 3. This led to the decision to increase the stratification of nutritional status.

Prospective cohort studies for monitoring the nutritional status associated with the lifestyle of this population may elucidate these cross-sectional observations, as there are controversies (33) regarding this study. The NSI and SENPE/SEGG (16, 17) suggested increasing the average values by one unit of BMI for each decade of life in both sexes, thus using more categories to classify the nutritional status of the elderly people (18). This classification was used to calculate the BMI, and nevertheless, a higher occurrence of overweight individuals was observed, which corroborated with other studies with the elderly (26, 2). Some studies have reported benefits of higher BMI in the rehabilitation of patients hospitalized for fractures (34) or other comorbidities (35). It is however necessary to create a single reference value that will best correlate the weight to the height by different age groups and genders, as, if only the BMI-NSI values (17, 18) from American or European standards are used, some stratum of classification of the BMI in the elderly may be underestimated or overestimated. Consequently this would decrease the surveillance, allowing non-transmissible chronic diseases (NCDs), resulting from having an overweight nutritional status throughout life with high BMI, to establish themselves in these elderly people. On the other hand, the data from this study indicate that individuals without morbidity were within the range of eutrophic and with morbidity in the overweight classification by the WHO(6) for adults, and were significantly different.

Compared to other studies (5, 36), the prevalence of malnutrition and the risk of undernourishment were similar(37), or lower in this study, however remain important. Considering both categories together, 28% of the elderly people were shown to be in these conditions through the BMI-NSI evaluation and 26% through the MNA, while Casas(5) observed 72% and

Kaiser (36) 69%. However, comparing the present study to these studies, the data were collected from primary care clusters in the households in the first study and in the European population of older seniors in the second. Conversely, the data of the present study were collected in the population, with the expectation that if the collection was carried out in LSIs, the percentage of malnourished individuals in the elderly population of Cuiaba would be higher. However, these data were unknown, and the early treatment of this condition can reduce morbidity problems (38, 15) and treatment costs (39).

Another study carried out with elderly women also in the northeast of Brazil, using samples collected in a community center, found percentages of malnutrition of 3.4%, overweight of 32.1% and obesity of 18.5% (40).These authors also observed a decreased incidence of malnutrition, even though the Northeast region is characterized by the high prevalence of malnutrition, whether of a proteic (kwashiorkor) or caloric nature (marasmus). So are found several controversial data in the literature, depending on the elderly populations studied. This reinforces the importance of knowing the reality of each population to better intervene and perhaps even create specific instruments of classification.

In this sense, the MNA is limited to classify elderly subjects with overweight and obese classified as "well-nourished", not allowing excess weight to be evaluated by categories. As was discussed (9, 29), excess weight can be an important predictor of morbidity and mortality in middle age or elderly people, and although, this relationship is not well established in the elderly. But, the present dates indicate that this population had a similar behavior therefore, and the MNA could not calculate the greatest risk factor present here, being necessary to use other tools such as BMI and the circumferences proposed in this study.

In relation to the new reference values for the circumferences, were adjusted from 24 cm to range of 27.1-29.00 cm for the arm differently the study (41) of rural elderly population in Africa Ghana 24 cm in circumference was found to arm normal BMI. Were adjusted of the 31 cm to range of 32.60-33.00 cm for the calf similar study de Arango-Lopera et al (42), were found to better correspond to the eutrophic condition, compared to previous studies (7, 8, 43, 44), furthermore, the classification was recalculated into five categories from malnutrition to obesity. For the AC the new calculated reference value was a range of 88.1-95.00 cm, measured transverse plane of the larger perimeter under the umbilical scar, to relate to the condition of eutrophy, slightly increasing the values proposed study by Lean´s (25). On the other hand, Cabrera´s, (28) showed increased mortality in elderly women with AC lower than 97 cm. So it seems that the range for the size of the abdominal circumference that provides a protective factor/normality is above the adult population. However this range should be further established and seems to be dependent on the population.

Additionally, this classification is new and in other further steps of our studies these measurements will be compared with nutritional biochemical markers (2, 16) for increased accuracy of classifications.

Conclusion

The elderly people assessed presented inadequate nutritional status, either overweight or underweight, evidencing the need to monitor these conditions to prevent comorbidities and preserve their physical independence. The anthropometric measurements were better able to stratify the nutritional status than the MNA. The BMI from WHO was better adjusted to health these elderly people than NSI and SENPE/SEGG, considering comorbidities of hypertension and diabetes mellitus. Furthermore, the proposed simple measurements of calf, arm, and abdomen circumferences, in order to evaluate the nutritional status appear to have been sufficient for this purpose.

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