Body mass index cutoff points and their relationship to chronic non-communicable diseases in older people

Arthur Felipe Alves da Silva Souza[1]
Mateus Gonçalves da Silva[2]
Andreia Cristiane Carrenho Queiroz[2]
Suely Maria Rodrigues[3]
Cláudia Lúcia de Moraes Forjaz[4]
Clarice Lima Álvares da Silva[1]

Abstract

Objective: To determine the association between nutritional status according to different cutoff points for body mass index (BMI) and the occurrence of noncommunicable chronic diseases (NCD) in older people. *Methods:* A cross-sectional study of 365 older people was conducted using a questionnaire collecting information on health variables, body weight and height measurements. The association between classification of nutritional status using BMI and occurrence of NCD was estimated by the Odds Ratio (OR) and 95% Confidence Intervals (95%CI). *Results:* As measured by the different BMI classification criteria, nutritional status varied: for normal weight (24.9-32.3%), excess weight (57.3-73.2%) and for underweight (1.9-15.3%). According to the Lipschitz classification, underweight was associated with lower occurrence of osteoarticular diseases (OR=0.38; 95%CI: 0.15-0.93) and cardiometabolic diseases (OR=0.42; 95%CI: 0.19- 0.94); while overweight was associated with higher occurrence of cardiometabolic diseases (OR=2.26; 95%CI: 1.30-3.93). According to the World Health Organization criteria, underweight was associated with lower occurrence of cardiometabolic diseases (OR=0.09; 95%CI: 0.01-0.61), overweight with lower occurrence of neuropsychological diseases (OR=0. 47; 95%CI: 0.26-0.87), while obese status was associated with higher occurrence of osteoarticular (OR=1.95; 95%CI: 1.08-3.52) and cardiometabolic (OR=3.02; 95%CI: 1.54-5.93) diseases. According to the Pan American Health Organization criteria, underweight was associated with lower occurrence of cardiometabolic diseases (OR=0.45; 95%CI: 0.22-0.91) and obese status with higher occurrence of osteoarticular (OR=1, 91; 95%CI: 1.16-3.15), cardiometabolic

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[1] Universidade Federal de Juiz de Fora - Campus Governador Valadares, Instituto de Ciências da Vida, Departamento de Nutrição. Governador Valadares, MG, Brasil.

[2] Universidade Federal de Juiz de Fora - Campus Governador Valadares, Instituto de Ciências da Vida, Departamento de Educação Física. Governador Valadares, MG, Brasil.

[3] Universidade Vale do Rio Doce, Departamento de Odontologia. Governador Valadares, MG, Brasil.

[4] Universidade de São Paulo, Escola de Educação Física e Esporte. São Paulo, SP. Brasil.

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Correspondence
Clarice Lima Álvares da Silva
clarice.silva@ufjf.edu.br

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(OR=2.58; 95%CI: 1.36-4.85) and respiratory (OR=1.96; 95%CI: 1.16-3.16) diseases. *Conclusion:* The classification criteria for BMI were negatively (underweight) and positively (excess weight) associated with the occurrence of NCD, exhibiting a stronger association when the overweight classification was differentiated from the obese classification.

INTRODUCTION

The Brazilian population has undergone a major change in the last few decades in line with global trends. The increase in proportion of older people[1] has been promoted by shifts in the health profile of the population as a result of epidemiological transitions. These changes include a decline in infectious parasitic diseases, a rise in chronic non-communicable diseases (NCD) and nutritional changes, characterized by a fall in cases of malnutrition and undernutrition, together with a rise in the prevalence of excess weight[2]. This dynamic has contributed to an increase in the incidence and prevalence of chronic NCD across all age groups and regions of Brazil[3].

The aging process promotes physical, physiological and behavioral changes which lead to alterations in body composition, favoring the occurrence of nutritional inadequacies and comorbidities in this age group. On a national level, rates of excess weight in the older population have risen significantly. Overweight in people aged older than 65 years was 43.9% in 2010, rising to 51.74% in 2020, when a total of 1,373,147 older individuals were classed as overweight[4]. In addition, the prevalence of diseases associated with metabolic syndrome (arterial hypertension, diabetes mellitus, central obesity and dyslipidemia) is greater among excess weight older adults[5].

Assessing the nutritional status of older people is an important tool in health care, requiring accurate reliable methods that are low-cost and easily-applied in population-based studies and in routine clinical practice[6]. The body mass index (BMI) is a proxy measure widely used in these settings. While this index possesses most of the necessary characteristics, its accuracy is questionable for individual assessment because, when applied alone, it cannot provide information on body composition or fat distribution, parameters affected by sex, race, ethnicity and, principally, by the age of the subject evaluated[6].

Another limiting factor of applying BMI in assessments of nutritional status of older individuals is the lack of consensus on the ideal cutoff points to be adopted. The classification proposed by the World Health Organization[7] (WHO) draws on an extensive North American population base that encompasses people of all ages, including older individuals. The cut-off points proposed by Lipschitz[8] offer greater sensitivity for diagnosing underweight and greater specificity for overweight. According to the authors, these cut-off points correspond to the BMI bands within which lower mortality is observed in the older population. Later, the Pan-American Health Organization (PAHO) made their recommendations based on data gathered for older populations of 7 countries of Latin America and the Caribbean, including Brazil, proposing even more sensitive BMI cut-off points for underweight, and more specific values for overweight, while also incorporating obese status as a diagnostic class in older people.

Given the scarcity of studies investigating BMI cutoff points for older Brazilians, the current ack of consensus, and increasing life expectancy and population aging, the objective of the present study was to determine the association between nutritional status according to different BMI cutoff points and the occurrence of chronic NCD in older users adults registered at the Family Health Strategy (ESF) units of the city of Governador Valadares. This study is of fundamental importance for its potential contribution to furthering knowledge in the area of aging and nutritional status assessment, as well as to clinical follow-up and decision-making in treatment and healthcare at all levels.

METHOD

A quantitative exploratory cross-sectional study within the context of the Family Health Strategy in the city of Governador Valadares, Minas Gerais state, was conducted. The city is located in the eastern

region of the state, 324 Km from the state capital city of Belo Horizonte. The city has a population of 263,689 people (11.7% older adults) with a mean income of R$ 678.74 per capita[10]. The main causes of death in this group are cardiovascular diseases, infectious diseases, parasitic diseases and cancers[11].

Data collection was carried out between 2018 and 2019. At the start of data collection, Governador Valadares had 56 Family Health Strategy units and 8 Family Health Support and Primary Health Centers, 37 of which were situated in urban regions with 20,097 registered older (≥ 60 years) users. The urban region of the city was divided geographically into 9 health districts/subregions each containing 2-10 ESF units. The sample was formed by selecting 10 ESF units, at least 1 unit per health district/subregion, so as to ensure coverage of the whole of the urban region and obtain a heterogeneous sample.

The sample comprised older adults aged ≥60 years of both genders. Sample size was calculated based on the number of older users registered at the ESF units within the urban region, an estimated rate of excess weight of 40%, accuracy of 5% and confidence interval of 95%. The calculation, after correcting for final n, based on the total users registered at the ESF units, yielded a sample size of 365 older adults, allowing for 10% losses.

The proportion of the sample by region was based on the total of older users registered at each ESF. This procedure was performed considering that each ESF represents a geographic region of the city. Thus, the chance to participate of older individuals from all the locations was assured. The registration number of each individual at their respective unit was listed and, subsequently, subjects to be approached to take part in the study were randomly selected using the "SORTEIO" (DRAW) app.

Inclusion criteria were: registered at selected ESF; agreed to home visit; aged ≥60 years; and signed the Free and Informed Consent Form. The study exclusion criteria were: failing to answer a question or not performing one of the measurements collected in the study.

Data collection was carried out at participants´ homes by previously trained undergraduates studying Nutrition, Physiotherapy and Physical Education courses and by graduates studying Physical Education, under the supervision of faculty members. A structured questionnaire was applied in the form of an interview collecting information on personal details (name, age and sex), social data (marital status, education, tobacco/alcohol use, and physical activity), economic aspects (source of income, monthly income in minimum wages) and health status (self-rated health, self-reported clinically-diagnosed diseases, medication use and number of medications used). Data collection time was, on average, 60 minutes.

Nutritional status of the participants was measured using BMI. Body weight was measured using portable digital electronic scales (Líder P150M®) with 200kg capacity and accurate to the nearest 50g. Height was determined using a portable stadiometer (Alturaexata®) with a capacity for measuring a maximum of 2 meters with graduations of cm and mm. Both readings were taken according to techniques reported in the literature[12]. In cases where the participant was unable to attain a standing/upright position during the assessment, weight and height were estimated using specific equations for older individuals[13]. The equation employed for females was: [1.83 x knee height] – [0.24 x age] + 84.88; and for males: [2.02 x knee height] – [0.04 x age] + 64.19. BMI was classified using the cut-off points defined by Lipschitz (1994)[8], the WHO[7], and the PAHO[9] (Chart 1).

Chart 1. Cut-off points for classification of body mass index (BMI).

Lipschitz (1994)[8]	
BMI values (kg/m^2)	Classification
<22	Underweight
22-27	Normal weight
>27	Overweight
World Health Organization (WHO, 1998)[7]	
BMI values (kg/m^2)	Classification
<18.5	Underweight
18.5-25	Normal weight
≥25-30	Overweight
≥30	Obese
Pan-American Health Organization (PAHO, 2002)[9]	
BMI values (kg/m^2)	Classification
<23	Underweight
23- 28	Normal weight
>28-30	Overweight
>30	Obese

Data were tabulated using double keyed entry to minimize errors. Normality of the data distribution was determined using the skewness coefficient. Categorical data were expressed as absolute (n) and relative (%) frequency, whereas quantitative data were expressed as either mean and standard deviation or median and minimum and maximum values.

The association of nutritional status according to different cutoff points for BMI and occurrence of chronic NCD was estimated using Odds Ratio (OR) and 95% Confidence Intervals (95%CI), taking normal weight as the reference category and adjusting results for age and sex.

The study was approved by the Ethics Committee for Research in Humans of the Federal University of Juiz de Fora (Permit no. 1.249.770), in compliance with the precepts stipulated in Resolution 466/2012. Data collection took place at participants´ homes, with authorization granted by the Department of Health Care of the city, which furnished details including the names and addresses of older users registered with the ESF units. All participants randomly selected in the sampling process signed the Free and Informed Consent Form prior to data collection. In cases of severe cognitive impairment, preventing the study subject from making an informed decision on participating in the present project, the Free and Informed Consent Form was instead signed by the legal guardian.

RESULTS

Regarding the sample of 365 participants, most (69.0%) individuals were female, median age was 69 (range 60-97) years, and most were living together with a partner. The majority of the sample had ≤8 years of education and received a monthly income via a salary or pension of 1-3 minimum wages (Table 1).

Results revealed that most respondents had never smoked, did not habitually consume alcohol, and had low level of engagement in physical activity. Most respondents had self-rated health of good/fair, whereas the median number of self-reported diseases was 4 and the presence of polypharmacy (use of ≥4 medications|) was observed in 46.1% of participants. The most prevalent disease class was cardiometabolic, followed by osteoarticular and gastrointestinal/renal (Table 2).

Mean BMI of participants was 28.6 ± 5.6 kg/m^2. Nutritional status was classified as adequate in 24.9-32.3% of the population. Excess weight, defined as overweight only or overweight plus obesity, ranged from 57.3% to 73.2%. The rate of underweight varied widely from 1.9% to 15.3% (Table 3).

The distribution of occurrence of chronic NCD and association with classification of nutritional state of participants is presented in Table 4. According to the Lipschitz[8] criteria, the occurrence of underweight was significantly associated with lower occurrence of both osteoarticular diseases (OR=0.38; 95%CI: 0.15-0.93) and cardiometabolic diseases (OR=0.42; 95%CI: 0,19-0,94), whereas overweight was associated with greater occurrence of cardiometabolic diseases (OR=2.26; 95%CI:1.30-3.93).

Table 1. Distribution of frequency of socioeconomic and health characteristics of participants (n=365). Governador Valadares, Minas Gerais state (2018-2019).

VARIABLES	DISTRIBUTION - % (n)
Gender (female) - %(n)	69.0 (252)
Age in years– median (min-max)	69.0 (60 – 97)
Living with partner - % (n)	57.5 (210)
Source of income - %(n)	
No income	13 (47)
Salary/pension	83.7 (302)
Social security benefits	3.3 (12)
Monthly income * - %(n)	
>1 MW	24.0 (79)
1-3 MWs	71.7 (236)
≥ 3 MWs	4.3 (14)
Education - %(n)	
≤ 8 years	58.6 (214)
>8 years	17.0 (62)
Tobacco use - %(n)	
Never smoked	55.4 (201)
Ex-smoker	36.1 (131)
Smoker	8.5 (31)
Alcohol use - %(n)	17.3 (63)
Self-rated health - %(n)	
Very poor	4.4 (16)
Poor	13.3 (48)
Fair	45.3 (164)
Good	31.8 (115)
Very good	5.3 (19)
Engages in physical activity - %(n)	27.1 (99)
Number of diseases – median (min-max)	4 (0-13)
Use of medications - %(n)	89.8 (324)
Number of medications	3 (0- 12)
Weight in Kg - mean (SD)	68.2 (13.6)
Height in m – mean (SD)	1.54 (0.09)

*MW=Minimum wage; MW at time of data collection (R$ 954.00 – R$ 998.00).

Table 2. Distribution of frequency of occurrence of main classes of diseases in participants. Governador Valadares, Minas Gerais state (2018-2019).

Classes of chronic NCD #	DISTRIBUTION - % (n)
Neuropsychological	33.9 (123)
Osteoarticular	42.0 (153)
Cardiometabolic	74.4 (270)
Respiratory	14.0 (51)
Gastrointestinal and/or renal	41.3 (150)

#= more than one reported alternative possible Neuropsychological = Parkinson´s Disease, severe memory problems, depression, chronic convulsions or epilepsy. Osteoarticular= arthrosis, rheumatism, osteoporosis. Cardiometabolic = health problems, diabetes mellitus, arterial hypertension. Respiratory = asthma, bronchitis, respiratory failure. Gastrointestinal and/or renal = urinary and fecal incontinence, gastric or duodenal ulcer, lower urinary tract symptoms, benign prostatic hyperplasia, chronic kidney disease stage IV or lower.

Table 3. Distribution of frequency of classification of nutritional status of participants according to cut-off points for body mass index. Governador Valadares, Minas Gerais state (2018-2019).

CUT-OFF POINTS	CLASSIFICATION - %(n)			
	Normal	Underweight	Overweight	Obese
Lipschitz	32.3 (118)	10.4 (38)	57.3 (209)	-
WHO	24.9 (91)	1.9 (7)	33.7 (123)	39.5 (144)
PAHO	31.8 (116)	15.3 (56)	13.4 (49)	39.5 (144)

WHO= World Health Organization; PAHO= Pan-American Health Organization.

When classified according to the WHO[7] criteria, underweight was significantly associated with lower occurrence of cardiometabolic diseases (OR=0.09; 95%CI: 0.01-0.61), while overweight was associated with lower occurrence of neuropsychological diseases (OR=0.47; 95%CI: 0.26-0.87). Obese classification was significantly associated with greater occurrence of osteoarticular diseases (OR=1.95; 95%CI: 1.08-3.52) and cardiometabolic (OR=3.02; 95%CI: 1.54-5.93) diseases.

Using the PAHO criteria[9], underweight was significantly associated with lower occurrence of cardiometabolic diseases (OR=0.45; 95%CI: 0.22-0.91), whereas obese classification was also associated with greater occurrence of osteoarticular diseases (OR=1.91; 95%CI: 1.16-3.15), cardiometabolic diseases (OR=2.58; 95%CI: 1.36-4.85) and respiratory disease (OR=1.96; 95%CI: 1,16-3,16).

Table 4. Distribution of frequency of occurrence of chronic diseases according to nutritional status classification. Governador Valadares, Minas Gerais state (2018-2019).

Classification	Classes of chronic NCD				
LIPSCHITZ	Neuropsychological	Osteoarticular	Cardiometabolic	Gastrointestinal and/or renal	Respiratory
Normal weight	30.5 (36)	39.8 (47)	67.0 (79)	39.8 (47)	11.0 (13)
Underweight	37.8 (14)	21.6 (8)	54.1 (20)	35.1 (13)	8.1 (3)
OR** (95%CI)	1.39 (0.64-3.0)	0.38 (0.15-0.93)	0.42 (0.19-0.94)	0.82 (0.38-1.77)	0.88 (0.40-1.90)
P	0.407	0.03	0.03	0.609	0.737
Overweight	35.1 (73)	46.9 (98)	82.2 (171)	43.3 (90)	16.8 (35)
OR** (95%CI)	1.08 (0.65-1.77)	1.03 (0.64-1.68)	2.26 (1.30-3.93)	1.15 (0.73-1.82)	1.14 (0.71-1.83)
P	0.777	0.890	0.004	0.546	0.576
WHO	Neuropsychological	Osteoarticular	Cardiometabolic	Gastrointestinal and/or renal	Respiratory
Normal weight	37.8 (34)	28.9 (26)	65.6 (59)	40.0 (36)	10.0 (9)
Underweight	42.9 (3)	42.9 (3)	28.6 (2)	28.6 (2)	28.6 (2)
OR** (95%CI)	1.1 (0.21-5.16)	1.38 (0.27-7.08)	0.09 (0.01-0.61)	0.68 (0.12-3.77)	3.74 (0.61-22.8)
P	0.950	0.693	0.01	0.660	0.152
Overweight	24.4 (30)	39.8 (49)	71.3 (87)	35.8 (44)	9.8 (12)
OR** (95%CI)	0.47 (0.26-0.87)	1.42 (0.77-2.56)	1.39 (0.75-2.56)	0.82 (0.47-1.45)	0.93 (0.37-2.32)
P	0.01	0.263	0.30	0.501	0.869
Obese	39.2 (56)	52.1 (75)	84.7 (122)	47.6 (68)	19.4 (28)
OR (95%CI)	0.85 (0.48-1.51)	1.95 (1.08-3.52)	3.02 (1.54-5.93)	1.35 (0.77-2.37)	2.00 (0.86-4.61)
P	0.582	0.03	0.001	0.296	0.106
PAHO	Neuropsychological	Osteoarticular	Cardiometabolic	Gastrointestinal and/or renal	Respiratory
Normal weight	29.3 (34)	36.2 (42)	69.6 (80)	38.8 (45)	10.3 (12)
Underweight	38.2 (21)	30.9 (17)	54.6 (30)	34.6 (19)	10.9 (6)
OR** (95%CI)	1.58 (0.80-3.14)	0.84 (0.41-1.71)	0.45 (0.22-0.91)	0.85 (0.43-1.67)	1.09 (0.39-3.12)
P	0.191	0.631	0.02	0.637	0.858
Overweight	24.5 (12)	38.8 (19)	77.6 (38)	36.7 (18)	10.2 (5)
OR** (95%CI)	0.71 (0.33-1.55)	0.97 (0.48-1.98)	1.78 (0.79-4.02)	0.88 (0.44-1.78)	0.93 (0.31-2.82)
P	0.393	0.939	0.161	0.730	0.894
Obese	39.2(56)	52.1 (75)	84.7 (122)	47.6 (68)	19.4 (28)
OR (95%CI)	1.33 (0.78-2.29)	1.91 (1.16-3.15)	2.58 (1.36-4.85)	1.43 (0.86-2.39)	1.96 (1.16-3.16)
P	0.290	0.010	0.004	0.172	0.010

WHO= World Health Organization; PAHO= Pan-American Health Organization; OR=Odds Ratio; CI= Confidence Interval, **= Adjusted for participant age and sex, *p*= probability of significance value.

DISCUSSION

The present study determined the association between nutritional status for different BMI cut-off points and occurrence of chronic NCD in older users registered at ESF units. The key findings were: a) all BMI cut-off points were associated with a reduction and/or increase in the occurrence of NCD; b) when applying the WHO criteria[7], underweight was associated with reduced occurrence of cardiometabolic diseases, overweight with reduction in neuropsychological diseases, while obese classification was associated with increased osteoarticular and cardiometabolic diseases; c) using the Lipschitz[8] criteria, underweight was associated with lower occurrence of osteoarticular and cardiometabolic diseases, whereas overweight was associated with greater occurrence of cardiometabolic diseases; d) based on the cut-off points recommended by the PAHO[9], underweight was associated with lower occurrence of cardiometabolic diseases, while obese status was associated with greater occurrence of osteoarticular, cardiometabolic and respiratory diseases.

The profile of the sample proved similar to that of the general older Brazilian population and of older users registered at the ESF units, i.e. predominantly female, low-educated and with low mean monthly income[14-16]. Low income was evident in the population studied, where 13% had no formal source of income and 71.7% lived on a monthly income of 1-3 minimum wages. A previous study of 2,369 older adults from all regions of Brazil found that, although majority had a low income, 95% contributed to the household finances and, of this group, 68% were the heads of household[15]. The present information on health behaviors showed a low level of physical activity and tobacco and alcohol use, mirroring results of the Surveillance System for Chronic Diseases – Telephone survey among older adults (≥ 65 years)[14]. Rates of medication use and polypharmacy in the sample were high at 89.8% and 46.1%, respectively, possibly due to the presence of multiple chronic NCD in this population group[17].

In recent decades, advancements in medical-health practices, chiefly disease prevention and treatment, have promoted an increase in life expectancy and a shift in the profile of typical diseases associated with aging[18]. Multimorbidity leads to disability and high use of health services, requiring the health system and professionals to devise strategies for monitoring and continuous updating toward promoting quality of life and longevity for the population[19]. In the older participants studied, there was a high prevalence of chronic NCD, particularly cardiometabolic diseases, consistent with reports in the literature. A Chinese cohort study involving 5,548 older adults found the most prevalent condition in the study was multimorbidity, affecting 70% of participants, particularly cardiometabolic and osteoarticular diseases[20]. Zhao *et al.*[21] assessed 5,749 in a Chinese city and found that 68.3% had cardiometabolic diseases, predominantly arterial hypertension. In Brazil, according to data from the last National Health Survey, 54.1% of the older respondents reported at least one NCD, 47.1% had two and 33.2% three or more diseases[3].

In addition to this epidemiological scenario, the present study revealed a substantial level of nutritional inadequacy, most notably a high prevalence of excess weight. As expected, the choice of criteria for classifying nutritional state had a major impact on the prevalence of nutritional inadequacy detected. Rates of underweight varied greatly, with only 1.9% of participants classified with this status using the WHO criteria[7] versus 15.3% using the PAHO criteria[9]. Overweight status ranged from 13.4% on the PAHO criteria[9] to 57.3% using the criteria defined by Lipschitz[8]. Overall, rates of obese status were the same, given that both sets of criteria that included this classification adopted the same cut-off point. Notably, irrespective of the cut-off point used, a high occurrence of nutritional inadequacies was observed, particularly excess weight, accounting for over half of the sample, with 1/3 of this group having a BMI >30 kg/m^2.

It is evident that there have been significant changes in the nutritional status of older people over the last few decades, as well as in the profile of diseases affecting this population group, comparing the context of life and health of older individuals today with that at the time the cut-off points were first created, when underweight was more prevalent and a greater concern in routine clinical practice,

along with excess fat as protection against common health outcomes in older people[22].

The results of the present study are similar to those reported in the literature, showing a rising rate of excess weight and obesity among older people over time relative to cases of underweight or malnutrition. A study investigating the agreement between the WHO and Lipschitz methods for classifying nutritional status of older people found that rates of excess weight (overweight/obesity) were high for both sets of cut-off points, at 50.4% and 31.3%, respectively[23]. Palma *et al.*[24], in a study comparing the Lipschitz[8] and PAHO[9] methods for classifying BMI in 424 older residents of a city located in the northern part of Rio Grande do Sul state, found similarly high rates of excess weight for both criteria (51.4% Lipschitz[8] versus 49.1 % PAHO[9]). In 2019, the Surveillance System for Chronic Diseases by Telephone Survey revealed a prevalence of overweight of 59.8% and of obesity of 20.9% in older people (≥ 65 years)[13].

The BMI cut-off points analyzed in the study are widely used for determining the nutritional status of older adults and assessing the risk of potential health problems as a result of being underweight or excess weight. The results clearly show that overweight and obesity were associated with the occurrence of chronic diseases in the population, whereas a diagnosis of underweight, according to some criteria, was associated with lower occurrence of diseases in this group. However, the occurrence of diseases among older individuals classified as underweight or normal weight highlights that, besides identifying the ideal cutoff point, the use of BMI as the sole marker of overweight/obesity is insufficient for predicting chronic diseases in the population or in clinical practice owing to its limitations[6].

As measured using the Lipschitz[8] classification, older individuals diagnosed as underweight had 62% lower odds of having osteoarticular disease and 58% lower chance of cardiometabolic diseases. Individuals classified as overweight had a 2.26 times greater chance of having cardiometabolic diseases. Neumann *et al.*[25] showed that, among a group of 112 older adults from the city of Roca Sales (Rio Grande do Sul state), those classified as overweight using the Lipschitz[8] method had a higher prevalence of arterial hypertension and diabetes. The study by Silveira, Vieira and Souza[2], however, using the same criteria in 418 older adults from the city of Goiânia (Goias state), found a higher likelihood of developing cardiometabolic and osteoarticular diseases in overweight individuals compared to normal weight and underweight subjects.

The results based on the WHO criteria[7] showed that a diagnosis of underweight was associated with a 91% lower chance of the occurrence of cardiometabolic diseases in this population, whereas overweight proved a protective factor for neuropsychological diseases, reducing the probability of occurrence by 53%. A classification of obese status increased the chance of osteoarticular diseases by 1.95 times and of cardiometabolic diseases by 3.02 times. Similarly, a study of 18,687 older individuals from different countries showed that elevated BMI (overweight and obesity) translated to a greater likelihood of diseases, especially cardiometabolic and osteoarticular, for all of the countries investigated[26].

As measured using the PAHO classification, underweight older adults had a 55% lower chance of having cardiometabolic diseases, whereas a diagnosis of obese status increased the chances of having osteoarticular diseases by 1.91 times, cardiometabolic diseases by 2.58 times, and respiratory diseases by 1.96 times. Using the PAHO criteria, Leal Neto, Barbosa and Meneghini[27] found that high BMI was involved in increased occurrence of cardiometabolic, osteoarticular and respiratory diseases in a sample of 477 older people of both sexes from the city of Antônio Carlos (Santa Catarina state). In a study assessing 436 older adults from Sarandi city (Parana state), Sass, Back and Marcon[28] found similar results using the same criteria, showing that individuals classified as obese had a higher likelihood of having cardiometabolic diseases, particularly diabetes and infarction.

Silveira, Kac and Barbosa[29] compared the factors associated with obese status for different sets of cutoffs (Lipschitz[8] and WHO[7] criteria) with the aim of determining which method was the most suitable for anthropometric classification of obesity from a public health perspective. The authors concluded that the most sensitive cut-off point for

diagnosing obese status for older Brazilians was a BMI > 27kg/m^2, i.e. the Lipschitz classification. Chapman[30] stated that the Lipschitz cutoff points are ideal for classifying nutritional status, with a focus on detecting malnutrition, also common in older people and associated with significant adverse health effects.

The use of the WHO cutoff points, developed in 1998[7], in older people requires caution, given that these do not take into account the potential body changes induced by the aging process, particularly at ages older than 70 years[6,28]. Nevertheless, the differential diagnosis between overweight and obese status, and the applicability of the same classification criteria throughout the life course, provide continuity of treatment planning. In a review by Martins, Meneguci and Damião[31] determining the most used cutoff point in surveys and studies involving the older population, found that the WHO criteria was the most widely employed, particularly by international studies of populations in developed countries and comparative studies conducted in Brazil.

Lastly, the cutoff points recommended by the PAHO[9] allow stratification of the diagnosis into overweight and obese classes, providing longitudinal follow-up of the population and continuity of the treatment delivered. Thus, given these reference values are based on a sample that includes older Brazilians, the PAHO cutoff points are recommended as criteria for determining nutritional status in this age group[28].

Evaluating the cutoffs as a whole, osteoarticular and cardiometabolic diseases showed a gradient relationship with nutritional status in older people. BMI values <22 kg/m^2 proved protective against diseases, whereas levels ≥30 kg/m^2 were risk factors for disease occurrence. As expected, cardiometabolic diseases were associated with nutritional status in older individuals and exhibited a greater gradient effect, where a lower prevalence of the disease was seen for a BMI <22 kg/m^2. Conversely, the odds of cardiometabolic disease for a BMI ≥27 kg/m^2 was 2.26 times higher, and 2.58-3.02 times higher for a BMI ≥30 kg/m^2. The results of a previous review showed that, irrespective of race or nationality, older people with a BMI ≥30 kg/m^2 had higher health risks compared with those who had lower BMI[32]. Notably, having a BMIv≤22 kg/m^2 exerted a protective effect against the disease classes assessed in the present study, but represents a risk factor for diseases associated with protein-energy malnutrition in this group[33].

Overall, the study results suggest the importance of diagnostic criteria for nutritional status in older individuals that use both the overweight and obese categories as a means of stratifying the higher risk of chronic NCD in the population with excess weight, given that classification criteria without this stratification, such as the Lipschitz[8] method, fail to detect this increased risk. This stratification provides ongoing clinical follow-up of the population throughout the aging process, allowing continuity of this diagnosis in obese adults that reach late life and definition of priority actions for care and treatment at all levels of health. This definition of care based on nutritional classification can be seen, for example, in the care protocol for the overweight and obese population of the national health system (SUS)[32].

The present study has some limitations, including its cross-sectional design, which precludes the establishing of any causal relationships, the possible presence of memory bias at interview, in addition to the fact that instruments were not used to assess cases deemed to have cognitive deficit potentially impairing judgment and decision to participate in the study. Assessment of these cases was instead carried out subjectively where, of the 356 participants, only 3 (0.84%) were not deemed capable of deciding whether to participate in the present project and therefore had a legal guardian sign the Free and Informed Consent Form on their behalf. Strengths of the investigation include data collection at households involving a representative randomly selected sample of older users registered with the primary health network, allowing the inclusion of different profiles, such as bedridden and frail individuals unable to access ESF units, and the investigation of a topic little explored in the scientific literature.

CONCLUSION

All of the BMI cut-off points were associated with higher or lower occurrence of chronic NCD

in the older participants investigated. Using the criteria proposed by the WHO, the underweight classification was associated with lower prevalence of cardiometabolic diseases; overweight with lower neuropsychological diseases; and obese status with higher osteoarticular and cardiometabolic diseases. Applying criteria specifically for older people showed that underweight was associated with lower occurrence of osteoarticular and cardiometabolic diseases. Excess weight (overweight on Lipschitz and obese on PAHO methods) was associated with higher rate of cardiometabolic disease and (obese on PAHO) osteoarticular and respiratory diseases. A stronger association with greater prevalence of chronic NCD was evident when overweight was differentiated from obesity, demonstrating the importance of the criteria adopting this stratification. These results can help further the knowledge in this area and, from a practical standpoint, improve integration of nutritional status assessment into strategies for monitoring the overall health of older adults and therapeutic decision-making.

AUTHORSHIP

- Arthur F. A. S. Souza - data extraction and tabulation; data analysis and interpretation; writing of manuscript; and approval of final draft.
- Mateus G. Silva – data extraction and tabulation; review of manuscript; and approval of final draft.
- Andreia C. C. Queiroz – conception and design; review of manuscript; and approval of final draft.
- Suely M. Rodrigues - review of manuscript; and approval of final draft.
- Cláudia L. M. Forjaz - review of manuscript; and approval of final draft.
- Clarice L. Á. Silva - conception and design; data analysis and interpretation; writing of manuscript; and approval of final draft.

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