Body fat percentage and body mass index in a probability sample of an adult urban population in Brazil

Composição corporal e índice de massa corporal em amostra probabilística de adultos de Niterói, Rio de Janeiro, Brasil

Composición corporal e índice de masa corporal en una muestra probabilística de adultos en Niterói, Río de Janeiro, Brasil

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Abstract

The purpose of the present study was to measure body composition in a probability sample of adults (≥ 20 years) living in Niterói, State of Rio de Janeiro, Brazil, and to assess the adequacy of the World Health Organization (WHO) recommended body mass index (BMI) cut-offs values for identifying obesity in this population. Anthropometric measures and percentage body fat (%BF) assessments were taken with 550 fasted individuals (352 women). Obesity was classified according to the WHO recommended BMI cut-off values. %BF predictive equations were developed based on the inverse of BMI. BMI and %BF mean values (standard error) were: 25.3kg/m² (0.3) and 38% (0.4) for women and 25.1kg/m² (0.3) and 22.1% (0.6) for men. The predicted %BF values (regression of %BF on the inverse of BMI) for each BMI cut-offs of 18.5, 25 and 30kg/m² were: 26.3%, 38.6% and 44.5% for women and 5.6%, 23.2% and 31.5% for men, respectively. The BMI values for the %BF-estimated obesity cut-off values were 20.5 for men and 25.7kg/m² for women. Based on the BMI-%BF relationship, the BMI cut-off values recommended by the WHO are not adequate in identifying obesity in adults from this population.

Body Fat Distribution; Body Composition; Body Mass Index; Obesity; Adult

Resumo

O presente estudo mediu a composição corporal em uma amostra probabilística de adultos (≥ 20 anos) de Niterói, Rio de Janeiro, Brasil, e avaliou a adequação dos pontos de corte do índice de massa corporal (IMC) da Organização Mundial da Saúde (OMS) para obesidade nessa população. Medidas antropométricas e de percentual de gordura corporal (%GC) por impedância bioelétrica foram obtidas em 550 (352 mulheres) adultos em jejum. A obesidade foi diagnosticada segundo os pontos de corte de IMC da OMS. Equações de predição para %GC em função do inverso do IMC foram desenvolvidas. Os valores médios (erro padrão) de IMC e %GC foram: 25,3kg/m² (0,3) e 38% (0,4) para mulheres e 25,1kg/m² (0,3) e 22,1% (0,6) para os homens. Os valores preditos de %GC para IMC de 18,5, 25 e 30kg/m² foram: 26,3%, 38,6% e 44,5% para as mulheres e 5,6%, 23,2% e 31,5% para os homens, respectivamente. Os valores de IMC para os pontos de corte para a obesidade baseados no %GC foram 20,5 (homens) e 25,7kg/m² (mulheres). Baseado na relação IMC-%GC, os pontos de corte de IMC propostos pela OMS não são adequados para identificar obesidade em adultos de Niterói.

Distribuição da Gordura Corporal; Composição Corporal; Índice de Massa Corporal; Obesidade; Adultos

Introduction

Obesity has increased worldwide and is now recognized as a major public health problem in both developed and developing countries [1]. It is estimated that around 1.5 billion adults were overweight in 2008, of which approximately 20% were obese [1]. In Brazil, a recent national survey showed that overweight affected approximately 50% of adults and that prevalence of obesity was 12.5% and 16.9% in adult men and women, respectively [2].

Obesity is defined as excess body fat [3]. Nevertheless, in epidemiological studies it has been mainly classified based on anthropometric data with surrogates for body composition rather than direct estimates of composition because body composition criterion methods are cumbersome and expensive, limiting their use in large-scale studies. Although little used, a possible alternative and affordable method to overcome this limitation is bioelectrical impedance [4]. Therefore, body mass index (BMI) continues to be the most commonly used variable for diagnosing obesity at the population level due to its simplicity and association with diseases [3]. However, the internationally recommended BMI cut-off values (25 to 29.9kg/m^2 for overweight and ≥ 30kg/m^2 for obesity) [3] have been criticized due to their inconsistent relationship with the body fat percentage (%BF) across populations [5,6,7,8,9,10,11,12,13,14,15]. These studies have demonstrated that there may be a significant variation in %BF for the same BMI range among different populations and even between individuals of the same population [8,11,12].

Given these findings, the objectives of the present study were to: (1) assess body composition in a probability sample of adults living in Niterói, in The State of Rio de Janeiro, Brazil; and (2) examine the relationship between %BF and the adequacy of the BMI cut-off values for identifying obesity recommended by the World Health Organization (WHO) in this population.

Materials and methods

The present study was based on data from the *Nutrition, Physical Activity and Health Survey* PNAFS, acronym in Portuguese) a household survey aimed at assessing the nutritional status and physical activity level of a probability sample of adults living in Niterói. Niterói is located in the Southeast Region of Brazil (22°53’00”S; 43°06’13”W). The city has an area of 131km^2 divided in 705 census enumeration areas of which 696 are exclusively residential areas.

The PNAFS was conducted between January and December 2003 based on a three-stage probability sample: census enumeration area, permanent private household and adults (≥ 20 years). The details of the sample design have been published elsewhere [16,17] but can be summarized as follows: in the first stage, 110 sectors were selected with probability proportional to the number of households from an ordered list according to average household income, thus allowing an implicit stratification of the census enumeration areas by income. In the second stage, 80 households were selected from each census enumeration area, with equal probability using inverse sampling [18]. The households were visited following the selected order until 16 interviews were obtained. In the third stage, one adult among all adults present in the interviewed household was selected with equal probability. Adults with cardiac or metabolic disorders and/or receiving medication that could alter heart rate or metabolism were not eligible for this study [17]. A sub-sample of five selected participants per census enumeration area (n = 550) were invited to carry out a series of physical and physiological measurements at the laboratory, including body composition and anthropometric measurements [17].

The anthropometric variables body mass, stature and hip circumference were measured by trained personnel using standardized procedures [19]. Body mass was measured once to the nearest 200g using a digital scale (Tanita model TBF-305, Tanita Corp., Tokyo, Japan). Stature was measured twice to the nearest 1mm using a wooden stadiometer. The mean of the two measurements was used in the analysis. BMI was calculated as the ratio between body mass (kg) and squared stature (m^2). Nutritional status was classified according to the following WHO criterion [3]: underweight (BMI < 18.5kg/m^2), adequate (BMI between 18.5 and 24.9kg/m^2), overweight (BMI between 25 and 29.9kg/m^2) and obesity (BMI ≥ 30kg/m^2). Hip circumference was measured in triplicate at the widest point over the greater trochanter with the subject standing with feet together. The average of the three measurements was used in the analysis.

Percentage body fat was assessed using a validated bioelectrical impedance scale system (Tanita TBF-305) [20,21,22,23,24] using the following gender-specific equations developed for this population by Wahrlich et al. [20]: resistive index (stature^2/impedance), body mass, hip circumference and age (R^2 = 0.82 and SEE = 3.2% for men and R^2 = 0.86 and SEE = 2.9% for women). Measurements were taken early in the morning after an overnight fast. Obesity, based on %BF, was classified according to the cut-off points proposed by the American Dietetic Association (ADA)/Canadian Dietetic Association (CDA) [25]: %BF ≥ 25 for men and %BF ≥ 30 for women.

The sample design weights (calculated as the product of the inverse of each stage inclusion probability) were calibrated in order to estimate the correct distribution of the population by age and gender [17,26]. The observed sub-sample of 550 subjects (198 men and 352 women) was representative of 324,427 adults (145,642 men and 178,785 women) residing in Niterói. Data analyses included descriptive statistics such as means, standard errors, 95% confidence intervals (95%CI; for comparisons between means and proportions) and minimum and maximum values. Due to the curvilinear nature of the %BF-BMI relationship [27,28], 1/BMI was used in the regression analysis of the relationship between BMI and %BF and vice-versa. The analyses were performed using the calibrated sample weights in the *surveymeans*, *surveyreg*, and *surveyfreq* procedures of the SAS, version 9.1 (SAS Inst., Cary, USA).

All research procedures were approved by the Institutional Review Board of the National School of Public Health of the Oswaldo Cruz Foundation (Escola Nacional de Saúde Pública Sergio Arouca, Fundação Oswaldo Cruz).

Results

Descriptive statistics are shown in Table 1. The Average BMI of women and men were 25.3 and 25.1kg/m^2, respectively. Average %BF was 38% and 22.1% for women and men, respectively. Based on BMI, both overweight and obesity were more prevalent in women than in men. The proportion of overweight and obese women was 31.4% and 15.9%, respectively, while the proportion men that were overweight and obese was 27.6% and 12.7%, respectively.

Percentage body fat increased progressively with increasing BMI levels in both men and women (Table 2). Women with a BMI between 18.5 and 24.9kg/m^2 already had, on average, high %BF. For women with a BMI between 25 and 29.9kg/m^2, %BF (41.8) was much higher than the ADA recommended cut-off point for obesity. Average %BF for men in the overweight category (BMI between 25 and 29.9kg/m^2) was 27.1%, above the cut-off point used to identify obesity suggested by the ADA.

BMI of women increased up to the age of 50 years due to an increase of fat mass given that lean mass remained practically unchanged (Table 3), after which point it began to fall due to a decrease in lean mass with a relatively stable %BF. This pattern was also observed in men.

The predictive equation derived from the inverse of BMI was (Figure 1): %BF = 73.72 - 876.88 x 1/BMI (R^2 = 0.88; SEE = 2.23) for women and %BF = 73.22 - 1,250.90 x 1/BMI (R^2 = 0.83; SEE = 3.49) for men. The addition of age in the model did not improve the estimations (R^2 = 0.89; SEE = 2.14 and R^2 = 0.86; SEE = 3.19, for women and men, respectively) and, therefore, the equations were discarded. Predicted %BF using the above equations at the BMI cut-offs of 18.5, 25 and 30 for women were: 26.3%, 38.6% and 44.5%,

Table 1

Physical characteristics and the distribution (%) of body mass index (BMI) of the adult population (age ≥ 20 years) of Niterói, State of Rio de Janeiro, Brazil. Data from the 2003 *Nutrition, Physical Activity, and Health Survey* (PNAFS, acronym in Portuguese).

	Women			Men		
	Mean	SE	95%CI	Mean	SE	95%CI
Age (years)	44.7	1.00	42.8-46.7	42.5	1.30	39.9-45.1
Body mass (kg)	63.9	0.73	62.4-65.3	74.1	1.08	72.0-76.2
Stature (cm)	158.9	0.34	158.2-159.6	171.8	0.69	170.4-173.1
BMI (kg/m^2)	25.3	0.29	24.8-25.9	25.1	0.31	24.5-25.7
Hip circumference (cm)	101.1	0.57	100.0-102.3	98.4	0.63	97.1-99.6
%BF	38.0	0.39	37.2-38.8	22.1	0.59	20.8-23.3
Fat-free mass (kg)	39.0	0.28	38.4-39.6	56.9	0.57	55.8-58.1
Fat mass (kg)	24.9	0.51	23.9-25.9	17.3	0.69	15.9-18.6

SE: standard error; %BF: percentage of body fat; 95%CI: 95% confidence interval.

Table 2

Estimated means, standard error (SE) and 95% confidence intervals (95%CI) of percentage body fat (%BF) according to the nutritional status of the adult population (age ≥ 20 years) of Niterói, State of Rio de Janeiro, Brazil. Data from the 2003 *Nutrition, Physical Activity, and Health Survey* (PNAFS, acronym in Portuguese).

BMI (kg/m²)	Women		Men	
	% (95%CI)	Mean±SE (95%CI)	% (95%CI)	Mean±SE (95%CI)
< 18.5	1.9 (0.3-3.5)	21.2±0.9 (19.4-23.1)	0.9 (0.0-2.3)	6.2±0.7 (4.7-7.7)
18.5-24.9	50.8 (44.5-57.1)	33.7±0.3 (33.0-34.4)	58.8 (50.6-66.9)	17.0±0.6 (15.9-18.2)
25.0-29.9	31.4 (25.3-37.5)	41.8±0.2 (41.3-42.2)	27.6 (20.1-35.1)	27.1±0.5 (26.0-28.2)
≥ 30.0	15.9 (10.7-21.2)	46.3±0.5 (45.3-47.3)	12.7 (7.7-17.7)	35.5±0.9 (33.8-37.2)

BMI: body mass index (body mass/stature²).

Table 3

Anthropometric and body composition values according to age groups and prevalence of obesity (body mass index – BMI ≥ 30kg/m²) in the adult population (age ≥ 20 years) of Niterói, State of Rio de Janeiro, Brazil. Data from the 2003 *Nutrition, Physical Activity, and Health Survey* (PNAFS, acronym in Portuguese).

Age group (years) [n]	Body mass (kg) Mean±SE	Stature (cm) Mean±SE	BMI (kg/m²) Mean±SE	%BF Mean±SE	Lean mass (kg) Mean±SE	Prevalence of obesity (%)
Women						
20-30 [85]	61.0±1.20	162.5±0.63	23.1±0.43	34.1±0.67	39.6±0.44	8.1
30-40 [69]	64.6±2.07	160.5±0.65	25.1±0.83	36.9±0.96	40.0±0.78	11.1
40-50 [95]	67.1±1.41	158.9±0.54	26.5±0.53	39.6±0.59	39.9±0.50	20.9
50-60 [59]	65.3±1.25	157.0±0.75	26.6±0.47	40.3±0.65	38.6±0.49	18.6
≥ 60 [44]	62.0±1.41	155.0±0.81	25.8±0.60	40.0±0.88	36.8±0.50	22.3
Men						
20-30 [46]	74.4±1.46	173.8±1.29	24.6±0.44	20.8±1.30	58.5±0.90	6.4
30-40 [59]	77.1±1.93	173.7±0.96	25.5±0.54	21.4±1.18	59.6±0.80	14.7
40-50 [53]	75.1±1.90	172.6±1.13	25.2±0.65	21.9±1.18	58.0±0.81	14.2
50-60 [19]	74.8±4.15	169.3±1.80	26.1±1.40	23.8±1.99	55.6±1.77	19.5
≥ 60 [21]	67.8±2.86	167.3±1.21	24.2±0.91	23.6±1.87	50.9±1.23	11.8

respectively. For men these values were 5.6%, 23.2% and 31.5%, respectively.

Using the %BF cut-offs suggested for obesity (30% for women and 25% for men) the predicted BMI values were 20.5 and 25.7kg/m² for women and men, respectively. These values are much lower than the cut-off values recommended by the WHO (30kg/m²) for both women and men.

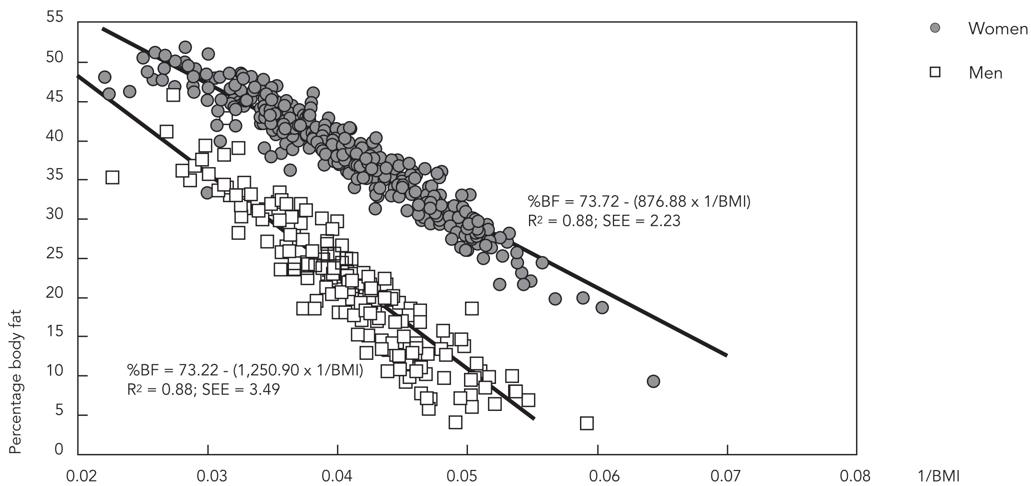
Discussion

The present study measured BMI and %BF in a probability sample of adults living in Niterói. The data showed that for women with BMI values under 25kg/m² and for men whose BMI were between 25 and 29.9kg/m², %BF was above the ADA [25] recommended cut-off values for obesity. These results corroborate findings of other studies which have documented high levels of %BF for lower BMI in population samples from a number of countries, including China [29], Japan [13], Indonesia [6], Ethiopia, Indonesia, Thailand [5] and Mexico [30].

Although the relationship between BMI and %BF varies according to body build, it may also be influenced by environmental factors such as energy intake and physical activity levels [10]. Several studies have consistently shown that certain populations have larger proportions of fat-free mass when compared to other specific populations, for example: Afro-Americans and Polynesians *vs.* Caucasians [5], Polynesians *vs.* Europeans [7], and Togolese *vs.* Australians [9].

Figure 1

Relationship between inverse body mass index (1/BMI) and percentage body fat (%BF) for the adult population of Niterói, State of Rio de Janeiro, Brazil. Data from the 2003 *Nutrition, Physical Activity and Health Survey* (PNAFS, acronym in Portuguese).



Deurenberg et al. [10] showed that the length of the lower limbs relative to stature has a clear influence on the relationship between BMI and %BF. For example, if you take two people with the same BMI but different body structure, the person who has a larger body structure is likely to have a greater amount of fat-free mass and consequently lower %BF. Similarly, if you take two people with the same %BF but different body structure, the one with shorter lower limbs is likely to have a relatively lower BMI in relation to %BF. Differences in body structure are well documented in blacks (torso and longer lower limbs) compared to whites [31], which may help explain the differences in body composition relative to BMI between these ethnic groups.

Adult women from Niterói had higher levels of %BF than men for all BMI categories. Body composition varies according to gender [32] and other investigators have shown that women have higher values of %BF than men in all age groups for the same BMI [27,33]. For the present study, for the same BMI range there was a large variation in %BF values in both men and women. In the normal BMI range (18.5 to 24.9kg/m^2), for example, %BF ranged between 4.1% and 27.2% in men and 21.6% and 41.5% in women. Similar differences in body composition regardless of gender have been documented in other population groups, e.g., Asians [8], Americans of various ethnic backgrounds [11] and Australians [12]. In fact, in the third NHANES [33], a mean BMI of roughly 26.5kg/m^2 for both men and women represented very different %BFs, estimated by bioelectrical impedance analysis, for women (35%) and men (23,9%). This led the authors to conclude that the diagnostic accuracy of BMI in detecting obesity is limited, particularly for individuals in the intermediate BMI ranges [33].

In addition to behavior characteristics, age-related changes in body composition also contribute to variations in the BMI-%BF relationship. For example, muscle atrophy and a decline in bone mineral mass along with changes in the amount and distribution of subcutaneous adipose tissue can be marked by a relatively stable body weight [34]. Mott et al. [35] showed an increase in body fat until 55-71 years of age after which it started to decline. Ito et al. [36] demonstrated a decline in fat-free mass and an increase in body fat as early as 40 years of age in both men and women. Analyzing a large sample of adults from the U.K., Meeuwsen et al. [28] showed that the increase in %BF with age was due more to a steady increase in fat mass than a reduction in lean mass as observed in adults in Niterói up to the age of 50 years. These differences in body composition confound interpretation of BMI as an index of adiposity with aging.

In the present study, BMI values corresponding to the %BF cut-offs for obesity (30% for women and 25% for men) [25] were 20.5 and 25.7kg/m^2 for women and men, respectively. These values are considerably lower than the BMI values recommended by the WHO [3] to define obesity (30kg/m^2). Ko et al. [29] also found lower values of BMI (22.5kg/m^2 for women and 23.1kg/m^2 for men) using the same approach in a sample of the Chinese population from Hong Kong. Other studies that have evaluated the performance of the WHO recommended cut-off point also found lower values of BMI: 27kg/m^2 for Indonesians [6], Chinese and Malaysians [8] and 26kg/m^2 for Indians [8]. Romero-Corral et al. [33] analyzed data from the NHANES III and showed discrepancies between the prevalence of obesity in categories based on BMI (19.1% and 24.7% in men and women, respectively) and %BF (43.9% and 53.3% in men and women, respectively). Goh et al. [37] also found that the BMI cut-off point of 30kg/m^2 had a low sensibility for classifying obesity in Asians. Thus, it is evident that the BMI of 30kg/m^2 underestimates the prevalence of obesity in many populations around the world including that of Niterói in Brazil.

The validity of the use of universal BMI cut-off points is questionable given the differences in the %BF-BMI relationship and the health problems associated with excess body fat in some populations with a BMI under 25kg/m^2 [14,30,38]. While universal BMI cut-off points make population comparisons easy, which may facilitate development of global health policies [39], even the WHO recognizes the inconsistencies in the relationship between BMI and %BF across populations [3,40]. Indeed, in 2004 the WHO suggested that more population-based studies were needed to clarify the differences in this relationship between different populations. Moreover, the WHO endorsed the use of lower BMI cut-off points for the Asian population [41] and recommended that outcomes be reported in BMI categories described previously in the literature.

It is important to note that the %BF cut-off values used to identify obesity in the present study were suggested by the ADA/CDA [25] and do not represent a consensus. Indeed, the WHO has long recognized that the use of BMI to classify individuals according to body fatness might result in misclassification [40] and has never issued a %BF cut-off value for obesity [3]. Current suggested %BF cut-off points for obesity are not based on health outcomes [42] but some have attempted to estimate these values from the BMI-%BF relationship using the traditional BMI cut-off values of 18.5, 25 and 30kg/m^2 for underweight, overweight and obesity, respectively [27], for which there is enough evidence of the association with morbidity and mortality [3]. Furthermore, most existing studies that result in values similar to the ones suggested by the ADA/CDA [25] were conducted with non-representative samples or without measures of health outcomes.

Williams et al. [43], using data of children and adolescents from the Bogalusa Heart Study, found an elevated risk of diseases such as hypertension and dislypidemia with %BF around 30% in girls and 25% in boys. Lohman et al. [44] suggested %BF values of between 22% and 25% for men, and 35% to 38% for women depending on age for identifying obesity. However, these values were generated from the distribution of anthropometric-estimated body composition values from a population-based U.S. survey. More recently, Heo et al. [45], analyzing the 1999-2004 NHANES data, documented that the %BF cutoff points derived from the %BF-BMI relationship are systematically higher in women and vary substantially according to age and ethnicity. Despite these efforts, the amount of body fat that can lead to health problems has yet to be established.

Since excess body fat is an important contributor to disease there is growing interest in conducting studies involving body composition assessment. The subjects of the present study are a sub-sample from a household survey. In addition to body composition, some other physiological measures were obtained [16,17,26] and adults with cardiac or metabolic disorders and/or receiving medication that could alter heart rate or metabolism were excluded from the study. While it is true that this policy may have excluded subjects in the upper distribution of percentage body fat and BMI, this does not compromise the analysis of the present study. The prevalence of obesity was similar and mean BMI values of the sub-sample was not significantly different from mean BMI of the total population of Niterói [16].

Bioelectrical impedance analysis is a simple, fast and inexpensive field technique. The main error in assessing percentage body fat from bioelectrical impedance analysis comes from variation in hydration status but temperature, exercise and food intake can also affect the results [44]. In the present study, measurements were taken early in the morning after an overnight fast to control these factors. Moreover, a validated impedance system and gender-specific equations developed for Brazilians [20] was used to estimate percentage body fat. Bioelectrical impedance analysis gives accurate estimates of average percentage body fat for a group and is valid and accurate in the context of the present study.

Bioelectrical impedance analysis has been used in some large-scale population-based studies [28,32,33,46] when appropriate population-specific equations were available [47], as in the present study. McCarthy et al. [46], for instance, used a similar bioelectrical impedance analysis device to develop %BF reference curves used by the U.K. Child Growth Foundation for clinical monitoring of body fat in children and adolescents.

Although anthropometric estimates of body composition have long been based on skinfold thickness [44] , the ratio of hip circumference and stature (the body adiposity index) has recently been suggested as a valid alternative method of percentage body fat assessment [48]. BMI remains the most commonly used method for diagnosing obesity in large scale epidemiological studies. Therefore, more studies on the association between body fat and health outcomes are needed in order to evaluate the continued use of the universal BMI cut-offs for measuring %BF versus simple field methods. Ideally these studies should be population-based, preferably longitudinal and should include different age groups and wide BMI and body composition ranges [10].

Conclusion

The BMI-%BF relationship differs significantly between the male and female adult population of Niterói. The WHO recommended BMI cut-off values may not be adequate for identifying obesity in this population.

Resumen

El presente estudio midió la composición corporal en una muestra probabilística de adultos (≥ 20 años) de Niterói, Río de Janeiro, Brasil, y evaluó la adecuación de los puntos de corte del índice de masa corporal (IMC) de la Organización Mundial de la Salud (OMS) para la obesidad en esta población. Las medidas antropométricas y de porcentaje de grasa corporal (%GC) por impedancia bioeléctrica se obtuvieron de 550 (352 mujeres) adultos en ayunas. La obesidad fue diagnosticada según los puntos de corte de IMC de la OMS. Se desarrollaron ecuaciones de predicción para %GC en función del inverso del IMC. Los valores medios (error patrón) de IMC y %GC fueron: 25,3kg/m² (0,3) y 38% (0,4) para mujeres y 25,1kg/m² (0,3) y 22,1% (0,6) para los hombres. Los valores previstos de %GC para IMC de 18,5, 25 y 30kg/m² fueron: 26,3%, 38,6% y 44,5% para las mujeres y 5,6%, 23,2% y 31,5% para los hombres, respectivamente. Los valores de IMC en los puntos de corte para obesidad basados en el %GC fueron 20,5 (hombres) y 25,7kg/m² (mujeres). Basado en la relación IMC-%GC, los puntos de corte de IMC – propuestos por la OMS – no son adecuados para identificar obesidad en adultos de Niterói.

Distribución de la Grasa Corporal; Composición Corporal; Índice de Masa Corporal; Obesidad; Adultos

Contributors

L. A. Anjos and V. Wahrlich planned the research, planned and conducted the analyses, critically revised the manuscript, and approved the final version of the manuscript. F. C. Teixeira planned and conducted the analyses, wrote the first draft of the paper and approved the final version of the manuscript. M. T. L. Vasconcellos planned the research, designed the sample and calculated the natural and calibrated sampling weights, critically revised the manuscript, and approved the final version of the manuscript. S. B. Going conducted the analyses, helped in the interpretation of the results and approved the final version of the manuscript.

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