Artículo Original / Original Article

Nutritional assessment of hospitalized patients: Comparison of real and estimated anthropometric measures

Evaluación nutricional de pacientes hospitalizados: Comparación entre medidas antropométricas reales y estimadas

Fabiana de Arruda Lucchesi^{1*}. <https://orcid.org/0000-0002-3541-5682>

Bruna Lúcia de Mendonça Soares². <https://orcid.org/0000-0003-4366-0183>

Joyce Canuto Rocha Lemos². <https://orcid.org/0000-0002-5018-7083>

Lúcia Maria Duque Moura². <https://orcid.org/0000-0001-8123-4578>

Patrícia Calado Ferreira Pinheiro Gadelha². <https://orcid.org/0000-0002-1387-0705>

1. Postgraduate Program in Clinical Nutrition - Institute of Biological Sciences, University of Pernambuco, Recife, Brazil.

2. Hospital da Restauração Governador Paulo Guerra, Recife, Brazil.

*Corresponding author: Fabiana de Arruda Lucchesi.
Postgraduate Program in Clinical Nutrition,
Institute of Biological Sciences, University of Pernambuco,
Rua José Braz Moscow, 978, apto 2208 Torre Lunar, Recife, Brazil.
E-mail: fabianalucchesi@hotmail.com

Este trabajo fue recibido el 31 de julio de 2020.

Aceptado con modificaciones: 18 de octubre de 2020.

Aceptado para ser publicado: 06 de noviembre de 2020.

ABSTRACT

The assessment of the nutritional status of hospitalized patients is fundamental to the establishment of the diagnosis. For bedridden patients, however, it is not possible to determine simple measures, such as weight and height, which are the most widely used variables for nutritional assessments. Objective: Compare real and estimated anthropometric measures in hospitalized patients. Methods: A cross-sectional study was conducted with adult (>18 years of age) and senior patients (>60 years of age) admitted for clinical or surgical treatment in the general surgery infirmary of Governador Paulo Guerra Restauração Hospital. Data (sex, age, clinical diagnosis, real weight, real height, body mass index, knee height and arm circumference) were collected using nutritional follow-up charts and tabulated using Excel 2016. Statistical analyses were performed in SPSS® version 21.0. Results: One hundred and twenty patients participated in the study (median age: 55 years). Most were adults (73.3%) and women (53.3%). The mean differences in weight between the estimated and real measures were statistically significant ($p=0.000$), with an overestimation of this variable. Regarding height, the estimated values differed significantly from the real values in both men and women ($p<0.000$) and the difference was larger among the seniors (mean: -0.072). No significant difference was found between the real and estimated body mass index ($p=0.44$). Conclusion: In the comparison of methods for estimating weight and height to real measures, a tendency was found to overestimate these body measures.

Keywords: Anthropometrics; Body Height; Nutritional assessment; Nutritional status; Weights and body measures.

RESUMEN

La evaluación del estado nutricional de los pacientes hospitalizados es esencial para establecer su diagnóstico. Sin embargo, para los pacientes postrados en cama, no se pueden realizar medidas sencillas como el peso y la altura, que son las más utilizadas para el diagnóstico nutricional. Objetivo: Comparar mediciones antropométricas reales y estimadas en pacientes hospitalizados. Metodología: Estudio transversal, que incluye pacientes adultos (>18 años) y personas mayores de 60 años, ingresados para tratamiento clínico o quirúrgico en la sala de cirugía general del Hospital da Restauração Governador Paulo Guerra. Los datos (sexo, edad, diagnóstico clínico, peso real, altura real, índice de masa corporal, altura de la rodilla y circunferencia del brazo) se recopilaban mediante los formularios de monitoreo nutricional y se tabularon en el software Excel 2016. Los análisis estadísticos se realizaron con SPSS®, versión 21.0. Resultados: 120 pacientes con mediana de 55 años, en su mayoría adultos (73,3%) y mujeres (53,3%). Las diferencias promedio entre las mediciones estimadas y reales fueron estadísticamente significativas, con sobreestimación del peso ($p < 0,0001$). Con respecto a la altura, fue posible identificar que las medidas estimadas diferían significativamente ($p < 0,0001$) de las reales para hombres y mujeres, y que esta variación era aún mayor entre los ancianos (media: -0,072). No hubo diferencias estadísticamente significativas entre el índice de masa corporal real y el estimado ($p = 0,44$). Conclusión: Al comparar las metodologías para estimar el peso y la altura con las mediciones reales, fue posible observar una tendencia de los métodos a sobreestimar estas mediciones corporales. Palabras clave: Antropometría; Estatura; Evaluación nutricional; Estado nutricional; Pesos y medidas corporales.

INTRODUCTION

The prevalence of malnutrition in the hospital environment has been intensively studied in the last twenty years. Studies carried out around the world have shown that the prevalence varies between 20 and 50% of inpatients^{1,2,3}. According to the Brazilian Hospital Nutritional Assessment Survey (IBRANUTRI), about 48.1% of hospitalized patients in the public health network had hospital malnutrition. Changes in nutritional status, especially in hospitalized patients, compromise immunity and functional capacity, negatively interfering with recovery⁴.

The assessment of the nutritional status of hospitalized patients is essential to establish a diagnosis on which the adequacy of nutritional therapy will be based. Thus, the screening aims to characterize the nutritional status and identify patients at risk⁵. One of the most important factors that contribute to the health and a proper functioning of the body is nutrition. In this sense, nutritional assessment is extremely important to improve treatment aiming to decrease the number of complications during hospitalization and hospitalization time, in addition to reducing hospital costs^{6,7}.

Despite its importance in monitoring and treating patients, the measurement of weight and height is not always possible, especially in critical patients, the elderly, bedridden patients, or those with bone diseases who cannot walk. In this situation, formulas to estimate the patient's weight and height were created in order to provide this data indirectly^{8,9}.

The World Health Organization recommends using estimated measurements for bedridden patients or those with some amputated limb¹⁰. Estimated weight and height measurements are routinely used in clinical practice for nutritional assessment. However, the accuracy and precision in hospitalized patients is unknown, as anthropometric assessment can be hampered by changes in body composition, impaired mobility, polytrauma, edema and ascites^{8,11}. Therefore, the objective of this study is to compare real and estimated anthropometric measurements in hospitalized patients, using the Chumlea formula for adults and the elderly, considering the wide use of this in clinical practice.

METHODOLOGY

We conducted a cross-sectional study analyzing nutritional monitoring files of a nutrition and dietary service. Participants were patients admitted to the General Surgery Clinic of the Hospital da Restauração Governador Paulo Guerra, Recife, PE, Brazil.

All adult (>18 years old) and elderly (>60 years old) patients admitted for clinical and surgical treatment, admitted from July to November 2019 and who underwent nutritional status assessment during this period were included. We excluded patients with peripheral edema, ascites or anasarca, limb amputation or paralysis, or those on dialysis and those whose anthropometric assessment was performed in the postoperative period.

We collected data on sex, age, clinical diagnosis, real weight (RW), real height (RH), body mass index (BMI), knee height (KH), and arm circumference (AC). Real weight was measured using a digital scale with a precision of 50 g and capacity for 200 kg (Welmy W200A Led). Height was measured using a stadiometer attached to the scale. Nutritional diagnosis was determined by BMI, obtained by dividing weight by squared height. The classification is according to the cutoff points proposed by the World Health Organization for adults and by the Pan American Health Organization^{12,13} for the elderly.

The arm circumference (AC) was measured in the arm against the peripheral venous access (PVA), as part of the hospital's nutritional assessment protocol. A percentage of adequacy between 90 and 110% was classified as normal weight^{14,15}. The knee height (KH) was measured with the patient sitting in a supine position or with the feet resting on the floor or bed. The knee height measurement was performed in relation to floor or bed height from the external bone point just below from the patella (tibia head) up to the surface¹⁶. Two measurements were made with an inextensible measuring tape, on the skin and the measured body region was adjusted to an accuracy of 0.1 cm.

Using data of AC and KH, the estimated weight was obtained using the predictive formulas Chumlea et al¹⁷ proposed. The estimated height was obtained using the formulas of Chumlea et al¹⁸ for adults and Chumlea et al¹⁶ for the elderly:

men= $[64.19 - (0.04 \times \text{age}) + (2.02 \times \text{knee height in cm})]$ and women= $[84.88 - (0.24 \times \text{age}) + (1.83 \times \text{knee height in cm})]$ ¹⁶. The patients included in the study met the criteria proposed by Chumlea for calculating estimated measures. Real weight and height measurements were obtained simultaneously with the measurements, arm circumference and knee height, used in the calculation of the predictive formulas. Using the estimated weight and height data, the estimated BMI was obtained. It is used to determine nutritional status considering the same cutoff points for adults and the elderly as described for real BMI.

Data were tabulated using the software Excel 2016 and statistical analyses were performed using SPSS®, version 21.0 (SPSS Inc., Chicago, IL, USA). The results were presented as tables with their respective absolute and relative frequencies. The normal distribution of variables was performed using the Kolmogorov Smirnov test. Continuous variables were presented as mean and standard deviation or median and interquartile range for normal and non-normal variables, respectively. Chi-square association tests, paired t test, and Pearson correlation test were performed. The Bland-Altman test was used to assess

the agreement between two different methods of measuring the quantitative variables weight and height. The linear regression test was used to assess the proportion bias in the distribution of differences. For the analysis of interobserver agreement of the anthropometric variables (weight, height and BMI) measured, the Kappa Test was performed. A 5% significance level was considered to reject the null hypothesis.

Data collection began after approval by the Ethics Committee of the Hospital da Restauração Governador Paulo Guerra, according to the Resolution of the National Health Council no. 466/12, under CAAE no. 10418919.5.0000.5198.

RESULTS

The final sample consisted of 120 patients. The median age was 55 years (minimum 19 - maximum 84 years). The majority were adults (73.3%) and females (53.3%). By assessing frequencies by sex, 56% of women had a clinical diagnosis of cholelithiasis. For males, the main clinical diagnosis was neoplasia (53.6%). Table 1 shows data according to demographic, clinical, and nutritional variables.

Table 1. Sample characterization according to demographic, clinical, and nutritional variables of patients admitted to a referral hospital in the city of Recife, PE, Brazil, 2019.

Sex (n= 120)	n	%
Female	64	53.3
Male	56	46.7
Age (n= 120)		
Adults	88	73.3
Elderly	32	26.7
Clinical diagnosis (n= 120)		
Perforation by stab/gunfire	4	3.3
Neoplasm	41	34.2
Cholelithiasis	46	38.3
Hernia	12	10.0
Non-surgical pathologies*	17	14.2
Nutritional status according to real BMI (n= 100)		
Malnutrition	14	14.0
Eutrophic	34	34.0
Overweight	52	52.0
Nutritional status according to estimated BMI (n= 120)		
Malnutrition	23	19.2
Eutrophic	34	28.3
Overweight	63	52.5

*Cholelithiasis and acute pancreatitis.

The average differences between estimated and real weight and height measurements were statistically significant ($p < 0.001$). This indicates overestimation of weight and height. Figure 1 shows the agreement analysis between the real and estimated weight measurements. There was a proportional bias in the distribution of differences with a tendency for concentrated values below or above the average ($p = 0.023$). Figure 2 shows the analysis of agreement between the measurements of real height and estimated height. A similar distribution was found between the differences with a trend of values close to the mean ($p = 0.092$). Despite this, comparisons between real and estimated BMI were statistically equal ($p = 0.44$), not compromising the final nutritional diagnosis. The most frequent nutritional diagnosis was eutrophy for males ($24.41 \pm 5.71 \times 23.10 \pm 5.59$) and overweight for females ($27.45 \pm 6.07 \times 29.07 \pm 6.23$). The results are similar regardless of the use of real or estimated data for calculating the BMI,

showing a substantial agreement when analyzed using the Kappa test ($k = 0.635$).

Table 2 shows the comparison of means, standard deviation, and significant difference of real measurements of weight, height, and calculation of real and estimated BMI.

Upon correlating real weight with estimated weight (Pearson's correlation test), only males did not show a statistically significant difference ($p = 0.717$). This suggests that there is a great possibility that the estimated data correspond to the real measurements for this demographic. By comparing females and stratifying between adults and the elderly, both showed a significant difference ($p < 0.001$). For females, the average difference between weight was -7.18 ± 7.59 kg.

Regarding height, the estimated measurements differed significantly ($p < 0.001$) from the real ones for men and women. This variation was even greater among the elderly (average of -0.072).

Figure 1: Bland-Altman curve for analysis between real and estimated weight measurements of patients admitted to a reference hospital in the city of Recife, PE, Brazil, 2019.

Figure 2: Bland-Altman curve for analysis of agreement between the real height and estimated height measurements of patients admitted to a reference hospital in the city of Recife, PE, Brazil, 2019.

Table 2. Comparison between real and estimated weight, height and BMI of patients admitted to a referral hospital in the city of Recife, PE, Brazil, 2019.

	Mean $\pm$ Standard deviation	Mean difference	p^*
Real weight (kg)	66.36 $\pm$ 16.69	-3.96	<0.001
Estimated weight (kg)	70.33 $\pm$ 18.25		
Real height (m)	1.60 $\pm$ 0.09	-0.04	<0.001
Estimated height (m)	1.64 $\pm$ 0.08		
Real BMI (kg/m ²)	26.02 $\pm$ 6.07	-0.24	0.44
Estimated BMI (kgm ²)	26.26 $\pm$ 6.62		

*Paired t test ($p < 0.05$).

DISCUSSION

Most of the sample consisted of adult women. They were overweight according to the real BMI and diagnosed with cholelithiasis. Female sex is an unmodifiable risk factor for cholesterol gallstones. It manifests particularly during the fertile period because of hormonal influences. The predominance is in overweight patients, a characteristic and diagnosis we found in the sample¹⁹.

Comparing the real and estimated weight using the Chumlea formula, which considers the parameters of arm circumference and knee height, we observed overestimated values. There was no significant difference only for males. For females, the mean difference was -7.18 ± 7.59 kg. Melo et al¹¹ found similar results, i.e., overestimation of the real body weight in comparison with several weight estimation formulas. The average difference was -3.35 ± 3.37 kg. Only the formula for adult men showed no significant differences compared to the real weight of adult men. This result is similar to that of Oliveira et al²⁰.

In addition to their use for determining nutritional needs and dietary prescription, weight and height are important for calculating the supply of medications and sedatives, dialysis treatment, water supply, and calculation of cardiac function indexes^{11,21}. If the values are underestimated, malnutrition and its complications may occur. On the other hand, if the measures are overestimated, there will be an overload in the supply of energy and medicines, which may cause hyperglycemia, hepatic steatosis, cardiac arrhythmias, edema, and respiratory failure²².

Regarding estimated height, all correlations showed a tendency towards overestimation compared to real height. The average difference was -0.039 cm. The greatest mean difference was in elderly males (-0.072 cm). The results found in our study are different from those of Melo et al¹¹. The Chumlea formula in their study was the only one that underestimated height compared to the real height²¹.

Even though elderly patients in our study showed height overestimation when assessed by knee height, it is important to note that elderly individuals often have spinal deformity. This makes it difficult to apply anthropometry. Therefore, it leads to wrong height measurements if using only a stadiometer. It is well defined in the scientific literature that the measurements of long bones do not suffer postural interference from aging and that, for this reason, they are better predictors of the real height value in comparison to other bone segments^{16,23}.

Although we observed significant differences between real and estimated weight and height, the comparison between real and estimated BMI did not show any differences in the classification of the final nutritional diagnosis. This result can be justified by the tendency to overestimate both estimated measurements.

One of the limitations of our study was the use and comparison of only one estimate to estimate weight and height. We did not consider other references found in the literature, however, we tested a formula widely used in

clinical practice, verifying the tendency to overestimate the results, with similar values only for adult men, possibly related to the smaller number of patients in the sample for the evaluation of the height parameter. In addition, the number of samples at the time of correlations was low. Few studies in the literature had the same objective as this study. However, the results obtained may be used to guide clinical practice.

CONCLUSION

By comparing the methodologies for estimating weight and height with real measurements, there was a tendency of methods to overestimate these body measurements. The only measurement that showed no significant difference was estimated weight for males.

Although there was no difference in the final nutritional status, most nutritional recommendations consider calories and proteins per kilogram of body weight, requiring the professional's careful evaluation when using estimated weight. In addition, more studies are needed to validate the existing equations according to the profile of the studied population and to evaluate their applicability.

Acknowledgements. To the Nutrition and General Surgery Services for encouraging scientific research and multidisciplinary work.

Founding source: The research is self-financed.

REFERENCES

1. Raslan M, Gonzalez MC, Dias MCG, Paes-Barbosa FC, Cecconello I, Waitzberg DL. Applicability of nutritional screening methods in hospitalized patients. *Rev Nutr.* 2008; 21: 553-561.
2. Correia MITD, Perman MI, Waitzberg DL. Hospital malnutrition in Latin America: A systematic review. *Clin Nutr.* 2017; 36: 958-967.
3. Isabel T. D. Correia M. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. *Clin Nutr.* 2003; 22: 235-239.
4. Waitzberg DL, Caiaffa WT, Correia MITD. Hospital malnutrition: the Brazilian national survey (IBRANUTRI): a study of 4000 patients. *Nutrition.* 2001; 17: 573-580.
5. Crestani N, Bieger P, Kik RME, Alscher S, Lienert RSC. Nutritional status of adults and elderly patients admitted in a university hospital. *Rev Ciencia Saude.* 2011; 4: 45-49.
6. Azevedo AS, Oliveira DC, Soares PKD, Jones KM, Soares FBD, Silva JN, et al. Nutritional profile of hospitalized adults and elderly people. *Rev Saude Pesquisa.* 2016; 9: 25-29.
7. Dalpiaz JS, Bertoni VM, Alves ALS, Bertol D. Nutritional status and its evolution during hospitalization in elderly patients. *Rev Bras Nutr Clin.* 2015; 30: 34-38.
8. Dock-Nascimento DB, Aguilar-Nascimento JE de, Balster MMS. Body mass index and weight theoretical underestimate the diagnosis of malnutrition in surgical patients. *Rev Bras Nutr Clin.* 2005; 20: 251-254.
9. Monteiro RSC, Cunha TRL, Santos MEN, Mendonça SS. Estimated weight, height and body mass index for american adults and elderly: review. *Com Ciencias Saude.* 2009; 20: 341-350.

10. WHO Expert Committee on Physical Status: the Use and Interpretation of Anthropometry (1993: Geneva, Switzerland) & World Health Organization, 1995.
11. Melo APF, Salles RK de, Vieira FGK, Ferreira MG. Methods for estimating body weight and height in hospitalized adults: a comparative analysis. *Rev Bras Cineantropom Desempenho Hum.* 2014; 16: 475-484.
12. PAHO, WHP. Multicenter Survey of Health, Well-being and Aging (SABE) in Latin America and the Caribbean: Preliminary Report. In: XXXVI Meeting of the Advisory Committee on Health Research; Kingston, Jamaica. 2002, p93. <http://envejecimiento.csic.es/documentos/documentos/paho-salud-01.pdf>
13. WHO Consultation on Obesity (1997: Geneva, Switzerland), World Health Organization. Division of Noncommunicable Diseases & World Health Organization. Programme of Nutrition, Family and Reproductive Health. (1998). Obesity: preventing and managing the global epidemic. Report of a WHO Consultation on Obesity. 1997, p178.
14. NN. Plan and operation of the Third National Health and Nutrition Examination Survey, 1988-94. Series 1: programs and collection procedures. *Vital Health Stat* 1. 1994; 32: 1-407.
15. Cronk CE. Anthropometric standards for the assessment of growth and nutritional status. *Am J Phys Anthropol.* 1991; 84: 104-105.
16. Chumlea WC, Roche AF, Steinbaugh ML. Estimating stature from knee height for persons 60 to 90 years of age. *J Amer Geriatrics Soc.* 1985; 33: 116-120.
17. Chumlea, W. M.; Guo, S.; Roche, A. F.; Steinbaugh, M. L. Prediction of body weight for the nonambulatory elderly from anthropometry. *J Am Diet Assoc.* 1988; 88: 564-568.
18. Chumlea WC, Guo SS, Ugh MLS. Prediction of stature from knee height for black and white adults and children with application to mobility impaired or handicapped persons. *J Am Diet Assoc.* 1994; 94: 1385-1388.
19. Stinton LM, Shaffer EA. Epidemiology of gallbladder disease: Cholelithiasis and cancer. *Gut Liver.* 2012; 6: 172-187.
20. Oliveira PM, Moreira APB, Garios RS, Elias MAR. Comparison of methods of estimating body weight and height in hospitalized patients. *HU Rev.* 2017; 43: 399-406.
21. Campos JADB, Prado CD, Pinelli C, Garcia PPNS. Methods of estimating height and weight assessment of malnutrition in patients with cancer. *Brazilian J Food Technol.* 2012; 23: 681-688.
22. Rezende FACR, Rosado LEFPL, Franceschini SCC, Rosado GP, Ribeiro RCL. Assessment of equations that estimate weight and height in adult men. *Rev Nutr.* 2009; 22: 443-451.
23. Alvarado HM, Valle RCV, Zavala RGD, Roman LA, Valencia M. Model for estimating standing height in Mexican adults for 20-59 years, based on knee length. *Nutr Hosp.* 2015; 32: 2855-2861.