RBCDH Revista Brasileira de CINEANTROPOMETRIA e Desempenho Humano

DOI: http://dx.doi.org/10.5007/1980-0037.2014v16n4p475

original article

Methods for estimating body weight and height in hospitalized adults: a comparative analysis

Métodos de estimativa de peso corporal e altura em adultos hospitalizados: uma análise comparativa

Ana Paula Ferreira Melo[1]
Raquel Kuerten de Salles[1]
Francilene Gracieli Kunradi Vieira[1]
Marilyn Gonçalves Ferreira[1]

Abstract – The aim of this study was to compare the values obtained through methods directed to height and body weight estimates in relation to measurements taken from hospitalized adult. Study participants were 142 adults of both genders. Anthropometric measurements of body weight, height, knee height, arm length, span, demi-span, recumbent height, calf, arm and abdominal circumferences and subscapular skinfold thickness were taken. The actual measurements were compared with those obtained from formulas for estimating weight and height, using the paired t test. The estimated measurements differed significantly (p <0.001) from the actual measurements in both genders, observing the tendency of overestimating these measurements. The exception was the estimated height for men by the formula that utilizes the variable knee height (p> 0.001). The average estimated body weight closest to the actual body weight for men was obtained with the formula that used the measurements of arm, abdominal and calf circumferences. For women, the biggest coincidences were obtained by means of the formula that utilizes the variable knee height. For both men and women, the averages related to the body mass index, calculated through estimated body weight and height measurements resulted in the same nutritional diagnosis when compared to the body mass index involving actual measurements. The estimated height by the formula that utilizes the variable knee height among men was the only measurement which did not represent significant differences. Other methodologies for estimating body weight and height presented significant differences, which suggests that new studies using other methodologies are necessary.

Key words: Anthropometry; Body composition; Body weights and measures; Estimation techniques.

Resumo – *Comparar valores encontrados mediante métodos direcionados às estimativas de peso corporal e altura em relação às medidas aferidas em adultos hospitalizados. Fizeram parte do estudo 142 adultos de ambos os sexos. Foram coletadas medidas antropométricas de peso corporal, altura, altura de joelho, comprimento de braço, envergadura de braço, semienvergadura, altura recumbente, circunferências de panturrilha, braço e abdome e espessura de dobra cutânea subescapular. As medidas realizadas foram comparadas com aquelas obtidas a partir de fórmulas de estimativa de peso e altura mediante teste t pareado. Em ambos os sexos, as medidas estimadas diferiram significativamente (p<0,001) das medidas reais, observando-se a tendência de superestimativa destas medidas. Exceção foi a altura estimada para homens pela fórmula que utiliza a altura de joelho (p>0,001). A média de peso corporal estimado mais próxima do peso corporal medido para homens foi obtida com a fórmula que utilizou medidas de circunferência de braço, abdome e panturrilha. Para as mulheres, as maiores coincidências foram obtidas mediante fórmula que utiliza altura de joelho. Tanto em homens quanto em mulheres, as médias relacionadas ao índice de massa corporal, calculado por intermédio de medidas estimadas de peso corporal e estatura, apontaram idêntico diagnóstico nutricional quando comparado com índice de massa corporal envolvendo medidas reais. A altura estimada pela fórmula que utiliza a altura de joelho entre os homens foi a única medida que não apresentou diferença significativa. As demais metodologias de estimativa de peso corporal e altura apresentaram diferenças significativas, demonstrando que novos estudos com outras metodologias são necessários.*

Palavras-chave: *Antropometria; Composição corporal; Pesos e medidas corporais; Técnicas de estimativa.*

1 Universidade Federal de Santa Catarina. Departamento de Nutrição. Florianópolis, SC. Brasil

Received: 05 August 2013
Accepted: 19 March 2014

INTRODUCTION

Nutritional assessment is a useful tool to support the therapeutic proposal and monitor the effectiveness of nutritional interventions, especially in hospitalized individuals[1]. Among the nutritional assessment methods, anthropometric measurements stand out, in which body weight and height are the most widely used. Both measures are essential for establishing the nutritional diagnosis and dietary and pharmacological prescriptions[2].

Subject who are bedridden and unable to walk require equipment and technological solutions to meet the need for weighing in bed. Scales integrated to hospital beds are examples, however, they have high costs and are not reality in hospitals[3].

Thus, many researchers have sought to develop methods to estimate body weight and height from specific measures of body segments that can be measured in these patients such as knee height, arm and calf circumferences, skinfold thickness, among others[4-10].

Considering the importance of measures such as body weight and height as essential indicators in the assessment of the nutritional status and the impossibility to take these measures in bedridden subjects, this study aimed to compare values found by methods aimed to estimate body weight and height most frequently used in clinical practice with measurements taken in hospitalized adults.

METHODS

This is an analytical, quantitative cross-sectional study conducted in a public hospital in southern Brazil from July 2011 to August 2012. The sample was obtained by convenience and selected according to the following criteria: adults aged 20-60 years of both sexes, able to walk and hospitalized in medical and surgical clinics in the aforementioned hospital. Subjects with peripheral edema, ascites or anasarca, with limb amputation or paralysis or on dialysis were excluded.

The project was approved by the Ethics Committee on Human Research of the Federal University of Santa Catarina, Protocol 1107. All study participants signed the informed consent form.

Anthropometric measurements were selected according to variables contained in the formulas for estimating body weight and height selected in this study (Box 1). The final data collection was preceded by training of the researchers involved, seeking to standardize procedures and measurement techniques.

Measurements were taken in the morning after a fasting period of 10 hours and after urination. Anthropometric measurements taken were height, body weight, semi-span (SS), span (S), recumbent height (RH), knee height (KH), arm length (AL), arm circumference (AC), calf circumference (CC), abdominal circumference (AC) and subscapular skinfold thickness (SEsf).

Box 1. Formulas analyzed in the present study.

Formulas used to estimate height	
Authors	Formula
Mitchell & Lipschitz[4] (A_1)	Height = semi-span x 2
WHO[4] (A_2)	Height = [0.73 x (2 x half of arm span)] + 0.43
Rabito et al.[2] (A_3 e A_4)	Height = 58.6940 – (2.9740 x sex*) – (0.0736 x age) + (0.4958 x arm length) + (1.1320 x semi-span) Height = 63.525 – (3.237 x sex*) – (0.06904 x age) + (1.293 x semi-span)
Gray et al.[13] (A_5)	Height = recumbent height
Chumlea et al.[4] (A_6)	White women: Height = 70.25 + (1.87 x knee height) – (0.06 x age) Black women: Height = 68.1+ (1.86 x knee height) – (0.06 x age) White men: Height = 71.85 + (1.88 x knee height) Black men: Height = 73.42+ (1.79 x knee height)
Cereda et al.[8] (A_7)	Height = 60.76 + (2.16 knee height) – (0.06 x age) + (2.76 x sex**)
Formulas used to estimate body weight	
Author/Year	Formula
Chumlea et al.[6] (P_1)	Women: Body weight (kg) = (1.27 x calf circumference) + (0.87 x knee height) + (0.98 x arm circumference) + (0.4 x subscapular skinfold thickness) – 62.35 Men: Body weight (kg) = (0.98 x calf circumference) + (1.16 x knee height) + (1.73 x arm circumference) + (0.37 x subscapular skinfold thickness) – 81.69
Rabito et al.[2] (P_2, P_3 e P_4)	Body weight (kg) = (0.5030 x arm circumference) + (0.5634 x abdominal circumference) + (1.3180 x calf circumference) + (0.0339 x subscapular skinfold thickness) – 43.1560 Body weight (kg) = (0.4808 x arm circumference) + (0.5646 x abdominal circumference) + (1.3160 x calf circumference) – 42.2450 Body weight (kg) = (0.5759 x arm circumference) + (0.5263 x abdominal circumference) + (1.2452 x calf circumference) – (4.8689 x sex*) ± 32.9241
Ross Laboratories[9] (P_5)	White women: Body weight (kg) = (knee height x 1.01) + (arm circumference x 2.81) – 66.04 Black women: Body weight (kg) = (knee height x 1.24) + (arm circumference x 2.81) – 82.48 White men: Body weight (kg) = (knee height x 1.19) + (arm circumference x 3.21) – 86.82 Black men: Body weight (kg) = (knee height x 1.09) + (arm circumference x 3.14) – 83.72

* 1 male; 2 female; ** 1 male; 0 female

Height was measured with Altura Exata® stadiometer fixed to a wall without footer, two meters high. To measure body weight, Tanita ® digital scales with maximum capacity of 150 kg was used with subjects standing barefoot and wearing only hospital garments. Both measures were assessed according to standards recommended by Jelliffe[11]. Body weight and height measurements were considered "gold standard" for comparisons performed in the present study.

To measure SS, the distance between the midpoint of the sternum and the distal phalanx of the right middle finger was measured by passing a flexible, inelastic measure tape parallel to the clavicle[4]. To assess S, measure tape was also used to measure the distance between the ends of the middle fingers of both hands with arms outstretched, leveling the shoulders[12].

RH measurement involved the individual's length obtained with a flexible, inelastic measure tape after marking the stretcher with chalk through the triangle from top of the head to the foot sole with patient in the supine position and with bed in complete horizontal position[13].

KH was measured with subject in the supine position with the right leg at an angle of ninety degrees with knee and ankle using Cescorf® caliper, comprising a fixed part, which was positioned in the plantar surface of the foot (heel) and a movable part pressed on the head of the patella (kneecap)[6].

AL was measured in the right arm with forearm flexed at ninety degrees, and measure was taken from the tip of the acromion process of the scapula and the olecranon process of the ulna, with measure tape on the lateral side of the arm[14].

Circumferences were measured with a flexible and inelastic measure tape on the right side of the body according to techniques proposed by Callaway et al.[15]. AC was measured at the midpoint between the acromion and the olecranon; CC in the maximum circumference of the calf muscle of the right leg and AC was assessed on the smallest horizontal circumference in the area between the ribs and the iliac crest.

SEsf was obtained by averaging three measurements with Lange® compass obliquely to the longitudinal axis. The caliper jaws applied 1 cm infero-lateral to the thumb and finger raising the fold, and the thickness is recorded to the rearest 0,1 cm. The orientation of the costal arches located one centimeter below the inferior angle of the right scapula[16].

Nutritional status was evaluated through the body mass index (BMI), calculated using the Body Weight (kg) / height (m)^2 coefficient. Nutritional status was classified according to cutoffs recommended by the World Health Organization (WHO)[17]. Forty-seven BMI combinations were calculated using estimated measures. We chose to examine only those with more satisfactory results.

Data were analyzed using the STATISTICA software, version 7.0. All variables were tested for normality by the Kolmogorov-Smirnov test. Assuming that all variables considered were normally distributed, the paired t test was used. As level of statistical significance, p value ≤ 0.05 was adopted.

RESULTS

The study included 142 adults, 74 (52.1%) were male. The average age of the sample was 42.5 years ± 11.1 years. Regarding nutritional status, overweight was identified in 29% of women and 28% of men.

Tables 1 and 2 show statistical information regarding actual and estimated height and body weight measures according to the different methods adopted.

Table 1. Comparison between actual and estimated height measures (m) of hospitalized adults

Height (m)	Mean	SD	Dif Mean	t	p
		Men			
Actual	1.71	0.08	-	-	
A_1	1.80	0.10	0.09	13.93	0.0000
A_2	1.74	0.07	0.03	6.54	0.0000
A_3	1.74	0.07	0.03	5.26	0.0000
A_4	1.73	0.07	0.02	4.53	0.0000
A_5	1.74	0.08	0.03	6.89	0.0000
A_6	1.71	0.09	-0.005	-0.59	0.5538
A_7	1.75	0.01	0.04	3.73	0.0003
		Women			
Real	1.58	0.06	-	-	
A_1	1.64	0.08	0.05	8.73	0.0000
A_2	1.63	0.06	0.04	8.27	0.0000
A_3	1.60	0.06	0.01	3.22	0.0019
A_4	1.60	0.06	0.01	2.79	0.0067
A_5	1.62	0.07	0.03	10.28	0.0000
A_6	1.56	0.07	- 0.02	-2.94	0.0044
A_7	1.61	0.09	0.03	3.53	0.0007

SD = Standard deviation; A_1 = Mitchell & Lipschitz[4]; A_2 = WHO[5]; A_3 e A_4 = Rabito et al.[2]; A_5 = Gray et al.[13]; A_6 = Chumlea et al. [7]; A_7 = Cereda et al.[8].

With respect to height, it was found that the estimated measures differed significantly (p <0.001) from actual measures for men and women. The exception was height estimated by the formula of Chumlea et al.[7] (A6) for men, which showed no significant mean difference (p> 0.05) compared to the actual measure. This formula was also the only one who underestimated actual height for females. Formulas developed by Rabito et al.[2] (A3 and A4) showed the closest measures of actual height for females.

The formula that showed the largest average difference from the actual height for both sexes was the formula that used the semi-span measure (A1)[4], overestimating the height by 9 cm for males and 6 cm for females. The formula of WHO (A2)[17], which uses the wingspan measure, also showed significant difference from the actual measure, but with lower mean differences (3 cm for males and 5 cm for females).

Mean differences between actual and estimated measures were significant (p<0.001), with overestimation of the actual body weight in all formulas of estimated weight for both sexes, with the exception of body weight obtained by the formula of Chumlea et al.[6] (P1), which underestimated body weight in women. Estimated body weight measures closest to the actual weight for men were obtained with the formulas of Rabito et al.[2] (P2 and P3) and for women with the formula of Chumlea et al.[6] (P1). Greater differences were obtained by using the formula of Ross Laboratories[9] (P5), which overestimated the actual body weight by 4.5 kg for males (-9.42, 18.48 kg) and 3.3 kg for females.

Table 2. Comparison between actual and estimated body weight measures (kg) of hospitalized adults

Weight (kg)	Mean	SD	Dif Mean	CI (95%)	t	p
		Men				
Actual	71.09	13.40	-	-	-	
P_1	75.50	12.83	4.41	2.85 – 5.96	5.64	0.0000
P_2	73.33	11.66	2.24	0.92 – 3.56	3.39	0.0011
P_3	73.03	11.43	1.93	0.60 – 3.26	2.90	0.0049
P_4	74.32	11.13	3.23	1.9 – 4.55	4.85	0.0000
P_5	75.62	13.15	4.53	2.88 – 6.18	5.47	0.0000
		Women				
Actual	69.34	18.77	-	-	-	
P_1	67.23	15.29	- 2.11	- 3.66 – - 0.56	-2.72	0.0082
P_2	76.46	15.29	7.12	5.90 – 8.34	11.64	0.0000
P_3	75.89	17.13	6.55	5.30 – 7.79	10.51	0.0000
P_4	72.29	16.73	2.95	1.70 – 4.19	4.72	0.0000
P_5	72.69	15.85	3.35	1.58 – 5.13	3.77	0.0003

SD = standard deviation; CI = confidence interval; P_1 = Chumlea et al.[7]; P_2, P_3 and P_4 = Rabito et al.[2]; P_5 = Ross Laboratories[9].

The averages of estimated BMI (24.68 kg/m² for males and 27.71 kg / m² for female) resulted in the same nutritional diagnosis of actual BMI: normal weight among males and overweight among females (Tables 3 and 4) .

Table 3. Comparison between actual and estimated body mass index values (kg / m²) of hospitalized male adults

Variables	Mean	SD	Dif Mean	t	p
Actual BMI	24.22	4.13	-	-	
BMI_1	24.51	4.91	0.29	1.08	0.2794
BMI_2	23.56	3.78	- 0.66	-4.80	0.0000
BMI_3	25.09	4.2	0.88	3.72	0.0003
BMI_4	25.37	4.94	1.16	3.31	0.0014
BMI_5	24.4	3.83	0.18	0.70	0.4856
BMI_6	24.99	4.12	0.77	3.26	0.0016
BMI_7	25.27	4.86	1.05	3.02	0.0034
BMI_8	24.30	3.75	0.08	0.31	0.7538

SD = standard deviation; Actual BMI = actual weight / (actual height) ^{2}; BMI_1 = actual weight /$(A_6)^2$; BMI_2 = actual weight /$(A_4)^2$; BMI_3 = P_2/(actual height)^2; BMI_4 = $P_2/(A_6)^2$; BMI_5 = $P_2/(A_4)^2$; BMI_6 = P_3/(actual height)^2; BMI_7 = $P_3/(A_6)^2$; BMI_8 = $P_3/(A_4)^2$; A_4, P_2 and P_3 = Rabito et al.[2]; A_6 = Chumlea et al.[7]).

For males, three of BMI analyzed showed no significant difference from the actual BMI: BMI 1, which used actual body weight and height estimated by Chumlea et al. (A6)[7] and BMI 5 and 8 that used body weight (P2 and P3 respectively) and height (A4) estimated by Rabito et al.[2] (Table 3). For women, only BMI 5 that used weight (P1) and height (A6) measurements estimated by formulas of Chumlea et al.[6,7] showed no significant difference from actual BMI (Table 4).

Table 4. Comparison between actual and estimated body mass index values (kg/ m^2) of hospitalized female adults.

Variables	Mean	SD	Dif Mean	t	p
Actual BMI	27.68	7.94	-	-	
BMI_1	28.45	8.17	0.77	3.22	0.0019
BMI_2	27.12	7.56	- 0.56	-3.29	0.0015
BMI_3	27.14	7.38	- 0.54	-2.90	0.0050
BMI_4	26.79	6.3	- 0.88	-2.74	0.0078
BMI_5	27.52	6.49	- 0.15	-0.41	0.6801
BMI_6	26.27	6.06	-1.40	-3.56	0.0006
BMI_7	26.29	5.86	- 1.38	-3.44	0.0010
BMI_8	28.92	7.37	1.24	4.81	0.0000
BMI_9	29.74	7.7	2.06	5.47	0.0000
BMI_{10}	28.32	6.95	0.64	2.21	0.0299
BMI_{11}	28.35	6.79	0.67	2.15	0.0349

SD = standard deviation; Actual BMI = actual weight / (actual height) ^{2}; BMI_1 = actual weight /$(A_6)^2$; BMI_2 = actual weight /$(A_3)^2$; BMI_3 = actual weight /$(A_4)^2$; $BMI_4 = P_1$/(actual height)^2; $BMI_5 = P_1/(A_6)^2$; $BMI_6 = P_1/(A_3)^2$; $BMI_7 = P_1/(A_4)^2$; $BMI_8 = P_4$/(actual height)^2; $BMI_9 = P_4/(A_6)^2$; $BMI_{10} = P_4/(A_3)^2$; $BMI_{11} = P_4/(A_4)^2$; A_3, A_4 and P_4 = Rabito et al. (2006); A_6 and P_1 = Chumlea et al.[7].

DISCUSSION

All estimated measures significantly differed from actual measures in both sexes, except for height for men using the formula of Chumlea et al.[7]. As in the present study, other authors[1,8,18] also found no significant differences when comparing actual height measurements to those estimated by Chumlea et al.[7].

This formula has the advantage of easy application, as it requires the measurement of a single measure, KH, requiring the use of one caliper.

One of the formulas of easy application and widely used in clinical practice to estimate height is the formula that used twice the half-span (A1)[4]. This measure showed the largest difference from the actual measured in the present study. Other studies[1,18] also found significant overestimation of the actual height with this measure. Other studies found different results[20-23], obtaining statistical similarity between actual height and twice the half-spam. The formula developed by WHO[5], which uses wingspan also resulted in statistically significant differences in this study, but with a smaller difference from the actual measurement. A similar result was found by Beghetto et al.[24], who obtained a significant difference between actual measure and that estimated by WHO[5], with a mean difference of 3 cm between them, which use was not recommended despite its easy application.

Recumbent height (A5)[13] also did not result in average height closer to the actual measure, overestimating 3 cm in height for males and 4 cm for females. A similar result was obtained by Rodrigues et al.[20].

In relation to methods to estimate body weight, this study showed a significant difference between actual and estimated weight measures for both sexes. Similar results were obtained by other authors[2,18,19]. Dock-Nascimento et al.[23] and Sampaio et al.[25] performed a study with adults and the elderly and obtained significant similarity between actual weight and that estimated by Chumlea et al.[6].

The best results of body weight estimation in this study were obtained using the formulas of Rabito et al.[2] for men and Chumlea et al.[6] and Rabito et al.[2] for women. The formula of Rabito et al.[2] was easy to be applied, which calculation uses only AL, AC and CC measured only with measure tape. The estimated body weight with the formula of Chumlea et al.[6] (P1) requires the SESF measurement, which may represent a negative factor because it requires measuring skinfold thickness, the researcher must be trained and the individual should remain seated during measurement.

With respect to BMI, it was identified that most measures showed significant difference from actual measures. For males, there was no significant difference when estimated and actual BMI were compared using actual body weight and that estimated by Chumlea et al.[7] (BMI1). This result was expected because this formula showed the best results to obtain height for men in the present study. BMI 5 and 8, which used weight (P2 and P3) and height (A4) measures estimated according to the formulas proposed by Rabito et al.[2], also showed no difference compared to actual BMI values. It is believed that this result may be due to the similar body composition among males of both studies, as in this study, the mean BMI was 24.2 kg / m² and 24 kg / m² in the study of Rabito et al.[2].

For females, there was no significant difference only between actual BMI and BMI_5, which combined weight (P1) and height (A6) estimated by Chumlea et al.[7]. This result may be associated with the fact that these estimated measures are the closest to actual measures among females in this study.

In the present study, estimated BMI that showed results closer to actual values were those that combined weight measured using the best height estimate for men. Few studies that assessed BMI using estimated measures were found, which makes the comparison with our results difficult.

CONCLUSION

By comparing methodologies for estimating body weight and height used in this study with actual measures, it was observed that these methods showed a trend of overestimating body measures in both sexes. The only estimated measures that showed no significant difference from the actual measure was height for men, using anthropometric variable knee height. This measure is of easy application in clinical practice.

With respect to the body weight estimation, no results showed significant similarity. Whereas weight variation is a strong indicator to assess the effectiveness of the therapeutic procedures, methodological alternatives for obtaining this measure should be proposed.

Given that BMI is the most widely used nutritional diagnosis method, we sought to identify which combinations of estimated weight and height would result in BMI more close to actual BMI. It was observed that the use of body weight and height obtained from formulas developed by the same author resulted in BMI more close to actual BMI.

There are still few national studies comparing different methodologies for estimating body weight and height in adults and especially analyzing the nutritional status of populations from these measures. Thus, further research should be carried out in order to validate existing equations and compare specific population groups using formulas that combine effectiveness, low cost and easy application.

REFERENCES

1. Rezende FAC, Rosado LEFPL, Franceschinni SCC, Rosado GP, Ribeiro RCL. Avaliação da aplicabilidade de fórmulas preditivas de peso e estatura em homens adultos. Rev Nutr 2009;22(4):443-51.
2. Rabito EI, Vannucchi GB, Suen VMM, Neto LLC, Marchini JS. Weight and height prediction of immobilized patients. Rev Nutr 2006;19(6):655-61.
3. Dias MCG, Horie LM, Waitzberg DL. Exame físico e antropometria. In: Waitzberg DL. Nutrição oral, enteral e parenteral na prática clínica. 4ª ed. São Paulo: Ed. Atheneu; 2009. p. 383-419.
4. Mitchell CO, Lipschitz DA. Arm length measurement as an alternative to height in nutritional assessment of the elderly. J Parenter Enteral Nutr 1982;6(3):226-9.
5. World Health Organization. Management of the Child with a Serious Infection or Severe Malnutrition. 1999; Available from: http://whqlibdoc.who.int/hq/2000/WHO_FCH_CAH_00.1.pdf > [2011 Jun 2].
6. Chumlea WMC, Guo SS, Roche AF, Steinbaugh ML. Prediction of body weight for the nonambulatory elderly from anthropometry. J Am Diet Assoc 1988;88(5):564-8.
7. Chumlea WMC, Guo SS, Steinbaugh ML. 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(12):1385-8.
8. Cereda E, Bertoli S, Battezzati A. Height prediction formula for middle-aged (30–55 y) Caucasians. Nutrition 2010;26(11-12):1075-81.
9. Ip.com. The Ross Knee Height Caliper. 2002. Available from: <http://ip.com/pdf/ipcompad/IPCOM000006911D.pdf> [2011 Jun 15]
10. Chumlea WMC, Roche AF, Steinbaugh ML. Estimating stature from knee height for persons 60 to 90 years of age. J Am Geriatr Soc 1985;33(2):116-20.
11. Jelliffe DB. The assessment of the nutritional status of the community. Geneva,1966. Available from: < http://www.ernaehrungsdenkwerkstatt.de/fileadmin/user_upload/EDWText/TextElemente/PHNTexte/WHO_FAO_Report/Jelliffe_Assessment_Buch_WHO_MONO_53_assessment_part1.pdf> [2011 Mar 20].
12. Barros DC, Silva JP, Felipe GC, Zaborowski EL. Antropometria. In: Barros DC, editor. SISVAN: Instrumento para o combate aos distúrbios nutricionais na atenção à saúde: A Antropometria. 20ª ed. Rio de Janeiro: Ed Fiocruz; 2005. p.51-58.
13. Gray DS, Crider JB, Kelley C, Dickinson LC. Accuracy of recumbent height measurement. J Parenter Enteral Nutr 1985;9(6):712-5.
14. Alvarez BR, Pavan AI. Altura e comprimentos. In: Petroski EL. editor. Antropometria: técnicas e padronizações. 1ª ed. Porto Alegre: Palotti, 1999. p.31-47.
15. Callaway CW, Chumlea WMC, Bouchard C, Himes JH, Lohman TG, Martin AD, et al. Circunferences. In: Lohman TG, Roche AF, Martorell R. editors. Anthropometric standardization reference manual. 15ª ed. United States: Human Kinetics, 1988. p.39-54.

16. Lee RD, Nieman, DC. Antropometry. In: Lee RD, Nieman DC. Editors. Nutritional assessment. 2ª ed. St Louis: Mosby, 1996. p.160-213.
17. World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO Consulation. Geneva: WHO; 1998. Available from: <http://libdoc.who.int/trs/WHO_TRS_894.pdf> [acesso 2011 20 mar].
18. Yugue SF, Ide HW, Tiengo A. Comparação da avaliação antropométrica em pacientes internados por intermédio de métodos estimativos e diretos. Rev Ciênc Saúde 2011;1(3):1-10.
19. Rodrigues PA, Rufino MCB, Correia EA, Lima JMR, Lisboa AAQ. Correlação das medidas antropométricas reais do peso e da altura com os métodos de estimativa em pacientes adultos do Hospital Regional de Ceilândia. Com Ciênc Saúde 2011; 21(3):237-44.
20. Brown JK, Whittemore KT, Knapp TR. Is arm span an accurate measure of height in young and middle-age adults? Clin Nurs Res 2000;9(1):84-94.
21. Bjelica D, Popovic S, Kezunovic M, Petkovic J, Jurak G, Grasgruber P. Body height and its estimation utilizing arm span measurements in Montenegrin adults. Anthropol Noteb 2012;18(2):69-83.
22. Dock-Nascimento DB, Aguilar-Nascimento JE, Costa HCBAL, Vale HV, Gava MM. Precisão de métodos de estimativa do peso e altura na avaliação do estado nutricional de pacientes com câncer. Rev Bras Nutr Clin 2006;21(2):111-6.
23. Mohanty SP, Babu SS, Nair NS. The use of arm span as a predictor of height: a study of south indian women. J Orthop Res 2001;9(1):19-23.
24. Beghetto MG, Fink J, Luft VC, Mello ED. Estimates of body height in adult inpatients. Clin Nutr 2006;25(3):438-43.
25. Sampaio HAC, Melo MLP, Almeida PC, Benevides ABP. Aplicabilidade das fórmulas de estimativa de peso e altura para adultos e idosos. Rev Bras Nutr Clin 2002;17(4):117-21.

Corresponding author

Raquel Kuerten de Salles.
Hospital Universitário Polydoro
Ernani de São Thiago.
Rua Prof. Maria Flora Pausewang, s/n.
Trindade. CEP: 88036-800
Florianópolis, SC. Brasil.
E-mail: raquel@hu.ufsc.br