ESTIMATED BODY WEIGHT AND HEIGHT IN OLDER ADULTS: AGREEMENT BETWEEN METHODS

Estimativa de peso corporal e estatura em idosos: concordância entre métodos

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ABSTRACT

OBJECTIVE: To compare different equations to estimate body weight and height in older adults and determine which ones provide the most reliable estimates. **METHODS:** This descriptive, cross-sectional study was conducted at a health clinic in Lagarto, Sergipe, Brazil. The sample consisted of older men and women who were able to walk. We measured body weight, body height, knee height, calf circumference, arm circumference, waist circumference, half arm span, and subscapular skinfold thickness. Then, we used different equations to estimate weight and height in that sample. The results of the equations were compared with actual measures of weight and height to determine their level of agreement. Paired t-test and Bland-Altman test were used in the statistical analysis. The level of statistical significance was set at $p \leq 0.05$. **RESULTS:** Sixty-three patients participated in the study. Most of them were women (74.6%), and mean age was 68.1 ± 5.8 years. Rabito et al.'s equation, which uses arm circumference to estimate height, showed a smaller mean difference from the actual measure. Regarding weight, Chumlea et al.'s equation showed a smaller mean difference. **CONCLUSION:** Those two equations are recommended to assess height and weight, especially in the older population.
KEYWORDS: anthropometry; aged; body height; body weight; estimation techniques.

RESUMO

OBJETIVO: Comparar os métodos de estimativa de peso corporal e altura em idosos e identificar o(s) melhor(es). **MÉTODOS:** Trata-se de um estudo do tipo descritivo e transversal realizado em uma clínica de saúde do município de Lagarto (SE). A população do estudo foram idosos de ambos os sexos com capacidade de deambulação. Aferiram-se peso corporal, altura, altura do joelho, circunferência da panturrilha, circunferência do braço, circunferência da cintura, meia envergadura do braço e prega cutânea subescapular, e foram avaliadas as equações de estimativa de altura e peso corporal. Em seguida, as equações foram comparadas aos valores de peso e altura aferidos, verificando-se se havia discordância entre essas variáveis. Utilizou-se o teste de correlação de Pearson, o teste t pareado e o teste de Bland-Altman. Para todos os testes, adotou-se como nível de significância estatística o valor de $p \leq 0,05$. **RESULTADOS:** Participaram do estudo 63 pacientes, sendo a maioria do sexo feminino (74,6%), com média de idade de 68,1 ± 5,8 anos. Notou-se que a equação de Rabito et al., que utiliza a circunferência do braço, apresentou menor diferença de média. Em relação ao peso, a equação de Chumlea et al. apontou a menor diferença de média para o peso aferido. **CONCLUSÃO:** Recomendam-se as equações supracitadas para a obtenção da altura e do peso corporal em idosos, especialmente nessa população.
PALAVRAS-CHAVE: antropometria; idosos; altura corporal; peso corporal; técnicas de estimativa.

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INTRODUCTION

The assessment of nutritional status is an instrument of great relevance, particularly in clinical practice, to assist in diagnosis of specific nutritional needs and prescription of nutritional therapy for each patient.[1] However, some of the measures included in this assessment may be troublesome, especially in older patients, inpatients, or nonambulatory patients.[2]

In older adults, anthropometric measurement is complex because of characteristics associated with aging, such as sarcopenia, reduced body water, and osteopenia. They lead to frailty, mobility difficulty, and flattened vertebrae, which interfere with the patient's ability to walk and hinder anthropometric measurement.[3,4] Some measures can be estimated, such as body weight and height, which are crucial for nutritional diagnosis and dietary prescription.[5]

Several equations to estimate weight and height are recommended in the literature for anthropometric assessment, but specific aspects should be considered when applying each of them. Incorrect choice and/or use of these equations may lead to errors that occasionally deteriorate the patient's nutritional status through inadequate dietary interventions.[6-8] In addition, most equations have been developed for the American population, with only few of them targeting the Brazilian population. Thus, their applicability for older Brazilians is limited, which may result in overestimated or underestimated anthropometric measures.

In this context, it is important to assess the use of equations to estimate weight and height in older adults, especially in Brazil, and determine which method is more adequate to obtain anthropometric measures, thereby providing reliable information on the patient's nutritional status. This study aimed to compare equations to estimate body weight and height with actual measures in older adults and identify which equations are more reliable.

METHODS

This descriptive, cross-sectional study was conducted at a health clinic in Lagarto, a city located in mid-southern Sergipe, Brazil. A convenience sample was selected consisting of older men and women who were able to walk. The exclusion criteria were older adults with visceromegaly, edema or burn preventing anthropometric measurement, lower limb amputation and/or paralysis, orthopedic deformities, ascites, and severe obesity.

The following anthropometric measures were collected: body weight (W), body height (H), knee height (KH), calf circumference (CC), arm circumference (AC), waist circumference (WC), half arm span (HAS), and subscapular skinfold thickness (SST). To measure weight and height, a previously calibrated Plenna digital scale (São Paulo, São Paulo, Brazil), with 150 kg capacity and 100 g precision, and a TBW portable stadiometer (São Paulo, São Paulo, Brazil) were used, respectively. KH was obtained using an anthropometer. CC, AC, WC, and HAS were obtained using a Cescorf inelastic measuring tape (Porto Alegre, Rio Grande do Sul, Brazil). SST was measured with a Lange skinfold caliper (Porto Alegre, Rio Grande do Sul, Brazil), with 0–60 mm scale and 1 mm resolution. These variables were measured according to the techniques described by Lohman et al.[9]

Several equations were used to estimate body weight and height, as described in Charts 1 and 2. The results of these

Chart 1 Equations to estimate height in older adults.

Code	Height	
	Author	Formula
H1	Chumlea et al.[10]	Women: H = (1.83 × KH) – (0.24 × A) + 84.88 Men: H = (2.02 × KH) – (0.04 × A) + 64.19
H2	Silveira et al.[11]	Men: H = 72.803 + (1.830 × KH) Women: H = 51.875 + (2.184 × KH)
H3	WHO[12]	$H_{(meters)}$ = 0.73 x [2 × HAS (m)] + 0.43
H4	Palloni & Guend[13]	Women: [I] H = 106.0251 + (1.1914 × KH) – (0.1539 × A) Men: [I] H = 105.9638 + (1.2867 × KH) – (0.1030 × A)
H5	Palloni & Guend[13]	Women: [II] H = 94.0667 + (1.2110 × KH) Men: [II] H = 98.1691 + (1.2948 × KH)
H6	Rabito et al.[5]	[I] H = 58.6940 – (2.9740 × S) – (0.0736 × A) + (0.4958 × AC) + (1.1320 × HAS)
H7	Rabito et al.[5]	[II] H = 63.525 – (3.237 × S) – (0.06904 × A) + (1.293 × HAS)

A: age (years); AC: arm circumference (cm); H: height (cm); HAS: half arm span (cm); KH: knee height; S: sex (1: male; 2: female); WHO: World Health Organization.

Chart 2 Equations to estimate body weight in older adults.

Code	BODY WEIGHT	
	Author	Formula
W1	Chumlea et al.[14]	Women: W = (1.27 × CC) + (0.87 × KH) + (0.98 × AC) + (0.4 × SST) – 62.35 Men: W = (0.98 × CC) + (1.16 × KH) + (1.73 × AC) + (0.37 × SST) – 81.69
W2	Rabito et al.[5]	[I] W = (0.5030 × AC) + (0.5634 × WC) + (1.318 × CC) + (0.0339 × SST) – 43.156
W3	Rabito et al.[5]	[II] W = (0.4808 × AC) + (0.5646 × WC) + (1.316 × CC) – 42.2450
W4	Rabito et al.[5]	[III] W = (0.5759 × AC) + (0.5263 × WC) + (1.2452 × CC) – (4.8689 × S) – 32.9241

AC: arm circumference (cm); CC: calf circumference (cm); KH: knee height; S: sex (1: male; 2: female); SST: subscapular skinfold thickness (mm); W: body weight (kg); WC: waist circumference (cm).

equations were then compared with the actual measures of weight and height in order to examine their level of agreement.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 20.0. The normality of data was assessed using the Kolmogorov-Smirnov test. Descriptive analysis and simple frequency were used to characterize the sample. The paired t-test was used to compare mean anthropometric measures (estimated and actual). The Bland-Altman test was used to assess agreement between actual and estimated weights and heights. The significance level was set at $p \leq 0.05$ for all tests.

The present study was approved by the Research Ethics Committee of Universidade Federal de Sergipe (UFS), with protocol no. 2.164.590. All older adults who participated in the study signed an informed consent form. This study is in accordance with the ethical principles established by the National Health Council Resolution no. 466, of December 12, 2012.

RESULTS

Sixty-three older patients were included in the study, 25.4% men and 74.6% women. Their mean age was 68.1 ± 5.8 years. Tables 1 and 2 show comparisons between estimation equations and actual measurements of mean weight and height. In the analysis of height estimation equations (Table 1), Rabito et al.'s equation H6[5] achieved the smallest mean difference (-0.16 cm) from actual height. It was followed by Palloni & Guend's equation H5,[13] whose mean difference (-1.96 cm), although smaller than those of the remaining equations, was statistically significant.

With regard to weight, equation W1 obtained the smallest mean difference (-0.74 kg) from actual weight, with no statistically significant difference. All the other equations overestimated body weight.

The agreement analysis of the methods to estimate height and weight (Figures 1 and 2) showed that equation H6 (Figure 1F) was the one that best agreed with actual height, overestimating it by 0.16 cm, while equation W1 (Figure 2A) overestimated actual weight by 0.74 kg. Both equations showed means close to zero, as well as a small bias in the Y-axis and smaller dispersion of these differences around the mean. The remaining equations showed low agreement between actual and estimated measures, with substantial dispersion.

DISCUSSION

The present study revealed that Rabito et al.'s equation H6[5] and Chumlea et al.'s equation W1[14] provide the most reliable estimates of height and weight, respectively. The height estimation equations overestimated actual height, but Rabito et al.'s equation H6[5] showed similar values. Although this equation was not developed specifically for older adults, it is a reference for estimating height in the Brazilian population, using variables such as age, sex, AC, and HAS.[6] According to Monteiro et al.,[8] this equation agrees better with actual height because of the use of AC when compared with Rabito et al.'s equation H7.[5]

Rabito et al.[2] conducted a study with adults and older adults at the University Hospital of Ribeirão Preto, São Paulo, and found that heights estimated by equations H6 and H7 strongly correlated with actual heights when compared with the equations proposed by Chumlea et al.[10] They observed that equation H7 agreed better with actual height.[2] Thus, there were similarities between actual heights and those estimated by the two equations used by Rabito et al.[5] Lima[7] also assessed Rabito et al.'s equations[5] in

older adults living in long-term care facilities in Natal, Rio Grande do Norte. The author observed that heights estimated by equation H7 were not statistically different from actual heights.

Although the previously cited studies found similar estimated and actual heights using Rabito et al.'s equation H7,[5] their results differ from those of the present study. It is clear that the equations described by Rabito et al.[5] have good reproducibility between actual and estimated height in older Brazilian adults, considering that studies report that geographical origin and ethnicity influence height.[8,15]

In the present study, Palloni & Guend's equation H5,[13] which uses KH, also provided similar heights when compared with other equations. This equation was developed using data collected from seven cities (Buenos Aires, Bridgetown, São Paulo, Santiago, Havana, Mexico City, and Montevideo) regarding the older population.[13] Although it is not widely used due to a lack of studies assessing its applicability, this equation could be an alternative to estimate height in older adults because it only requires KH, which can be easily obtained.

The equations that disagreed with actual height in the present study were the following: Chumlea et al.'s,[10] Silveira et al.'s,[11] World Health Organization's,[12] Palloni & Guend's equation A4,[13] and Rabito et al.'s equation A7.[5] The wide applicability of Chumlea et al.'s[10] equations to obtain height in older Brazilians is remarkable. However, conflicting results were demonstrated by Fogal et al.,[16] who found a significant difference between actual and estimated heights in older women in Viçosa, Minas Gerais. According to the authors, the precision of this equation is reduced when it is used in a different population from the original one.[16]

Regarding weight estimation equations, only Chumlea et al.'s equation[14] did not provide a significantly different estimated weight from actual weight. Similar results were achieved by Oliveira & Fernandes Filho.[17] Conversely, Barceló et al.[18] used this equation in older adult inpatients and found that weight was underestimated, with a statistically significant interclass correlation coefficient (r=0.926). There is a lack of studies comparing actual measures of weight and height with equations to estimate them in older adults, as most related studies investigate adult inpatients.[19]

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

Height (kg)	Mean (SD)	Mean difference	95%CI	p
Actual	153.05 (8.91)	–	–	–
H1	158.10 (8.35)	-5.05	-6.44 – 3.67	< 0.001
H2	158.56 (9.15)	-5.51	-7.00 – -4.02	< 0.001
H3	158.67 (8.49)	-5.62	-6.84 – -4.40	< 0.001
H4	155.51 (7.45)	-2.47	-3.77 – -1.16	< 0.001
H5	155.02 (7.47)	-1.96	-3.27 – -0.65	0.004
H6	153.21 (8.05)	-0.16	-1.32 – 0.99	0.775
H7	155.61 (8.53)	-2.56	-3.76 – -1.36	< 0.001

H1: Chumlea et al.;[10] H2: Silveira et al.;[11] H3: World Health Organization;[12] H4 and H5: Palloni & Guend;[13] H6 and H7: Rabito et al.;[5] SD: standard deviation; CI: confidence interval.

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

Weight (kg)	Mean (SD)	Mean difference	95%CI	p
Actual	65.42 (12.59)	–	–	–
W1	66.16 (12.63)	-0.74	-1.98 – 0.49	0.236
W2	73.34 (12.39)	-7.92	-9.32 – -6.53	< 0.001
W3	72.83 (12.17)	-7.41	-8.79 – -6.02	< 0.001
W4	70.39 (12.56)	-4.97	-6.19 – -3.74	< 0.001

W1: Chumlea et al.;[14] W2, W3 and W4: Rabito et al.;[5] SD: standard deviation; CI: confidence interval.

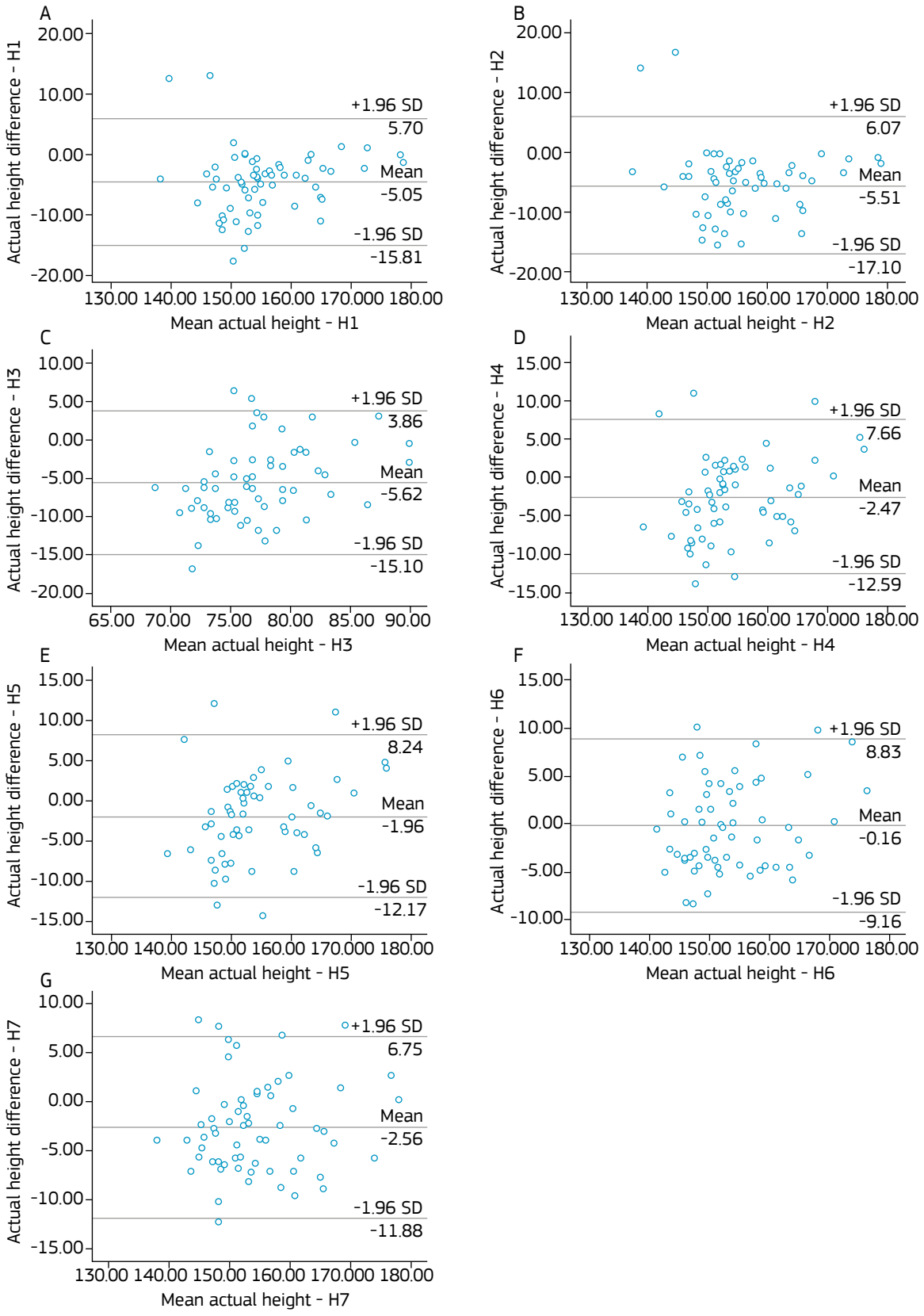

Figure 1 Agreement between actual and estimated height using Bland-Altman analysis: A1) Chumlea et al.;[10] A2) Silveira et al.;[11] A3) World Health Organization;[12] A4 and A5) Palloni & Guend;[13] A6 and A7) Rabito et al.[5]

The present study contributes to the evaluation of the most adequate methods to estimate weight and height in the older population, as well as of the equations that significantly disagree with actual measures in that population, thereby reducing underestimation and/or overestimation. However, the results should be interpreted with caution because of the limitations of this study, including sample size and number of equations assessed. Therefore, there is a need for further studies evaluating the applicability of equations to estimate weight and height in older adults, as they are commonly used in outpatient clinics, offices, and hospitals, and may positively influence dietary prescription and nutritional evolution.

CONCLUSION

In the present study, Rabito et al.'s equation H6[5] and Chumlea et al.'s equation W1[14] showed better applicability for estimating height and weight in older adults, respectively. Nonetheless, to use these equations more precisely, future studies should assess and develop predictive equations for specific populations, including older Brazilian adults, which would produce more reliable data.

CONFLICT OF INTERESTS

The authors declare no conflict of interests.

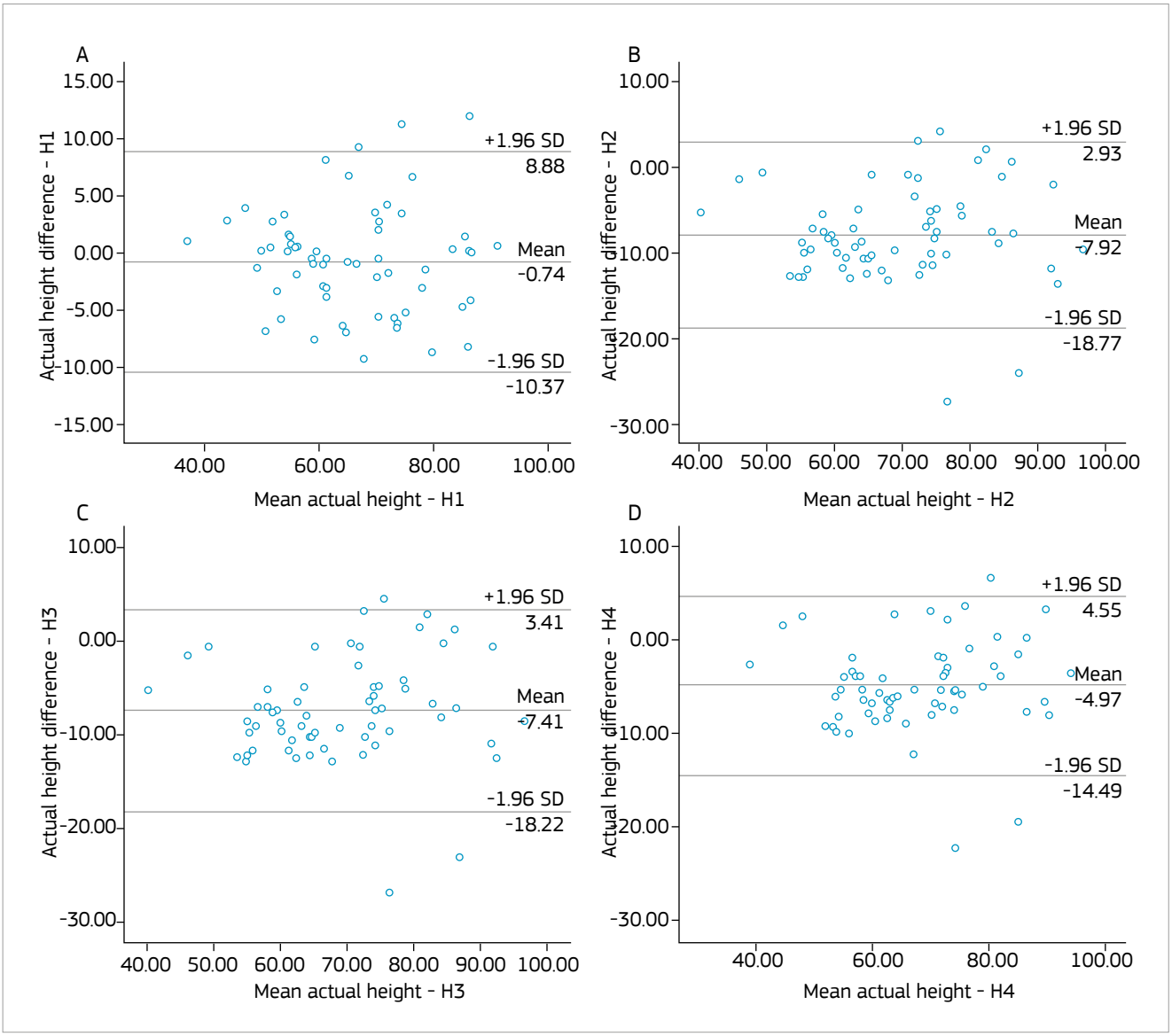

Figure 2 Agreement between actual and estimated weight using Bland-Altman analysis: W1) Chumlea et al.;[14] W2, W3 and W4) Rabito et al.[5]

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