The American Journal of Clinical Nutrition

Ability of new octapolar bioimpedance spectroscopy analyzers to predict 4-component–model percentage body fat in Hispanic, black, and white adults[1–3]

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ABSTRACT

Background: New, vertical, 8-electrode bioimpedance spectroscopy (BIS) analyzers provide detailed body-composition and nutritional information within 2 min. This is the first report on BIS's accuracy in predicting relative fatness [percentage body fat (%BF)] in a heterogeneous sample according to a multicomponent model criterion.

Objective: We compared %BF measurements from 2 BIS devices with those from a multicomponent model in a sample of Hispanic, black, and white adults.

Design: Equal numbers of apparently healthy men and women ($n = 75$ of each) from each racial-ethnic group, diverse in body mass index and age, volunteered. Reference %BF ($\%BF_{4C}$) was computed by using a 4-component (4C) model with total bone mineral content obtained from dual-energy X-ray absorptiometry, body density from underwater weighing with measured residual lung volume, and total body water from traditional BIS. Estimations from InBody 720 ($\%BF_{720}$) and InBody 320 ($\%BF_{320}$) BIS analyzers were validated against $\%BF_{4C}$.

Results: The $\%BF_{720}$ ($r = 0.85$, SEE = 5.19%BF) and $\%BF_{320}$ ($r = 0.84$, SEE = 5.17%BF) correlations were significant ($P < 0.05$) in the men; main effects were nonsignificant. Correlations for $\%BF_{720}$ ($r = 0.88$, SEE = 4.85%BF) and $\%BF_{320}$ ($r = 0.89$, SEE = 4.82%BF) also were significant in the women ($P < 0.05$); there was a main effect for method but not race-ethnicity. There were no sex-specific overestimations or underestimations at the extremes of the distributions.

Conclusions: BIS estimates of $\%BF_{4C}$ were well correlated in men and women. There were no significant methodologic differences in the men. The $\%BF_{4C}$ was significantly underestimated by $\%BF_{720}$ and $\%BF_{320}$ in the women. *Am J Clin Nutr* 2008;87:332–8.

KEY WORDS Bioimpedance spectroscopy, BIS, multicomponent model, percentage body fat, %BF, adults, men, women

INTRODUCTION

Water is the largest, most variable constituent of fat-free mass (FFM). Human body water content has been reported to vary with age (1, 2), body fatness (2), sex (3), and muscularity (4). In body-composition assessment, the bioimpedance spectroscopy (BIS) technique uses a spectrum of electrical frequencies to predict the intracellular water (ICW) and extracellular water (ECW) compartments of total body water (TBW). Low-level frequencies (eg, 1–50 kHz) rely on the conductive properties of extracellular fluid, whereas, at high-level frequencies (eg, 250 kHz), the conductive properties of both ICW and ECW are instrumental. Fat-free mass (FFM) and fat mass (FM) can be calculated from single- and multiple-frequency bioimpedance analysis (BIA) after the application of previously determined constants representing the water contribution to FFM. Validation of TBW assessment from traditional tetrapolar BIS by using an isotope-dilution criterion for adult samples was previously reported (5, 6).

Vertical, 8-point, tactile BIS analyzers have recently been discussed in the scientific literature and have appeared at trade shows and on the commercial market. These new analyzers use 4 pairs of electrodes (octapolar technology) embedded into the analyzer's handles (thumb and palm electrodes) and floor scale (ball of foot and heel electrodes), thereby combining upper-, lower-, and total-body bioimpedance to estimate FFM and percentage body fat (%BF) from the summation of ICW and ECW. For each of the frequencies of the BIS analyzers (InBody 720 and InBody 320; Biospace Co, Ltd, Seoul, Korea), an alternating current intensity (I) of 250 μA is applied between the right palm electrode (E1) and the electrode at the ball of the right foot (E5). The voltage drop (V) recorded between the right and left thumb electrodes (E2 and E4, respectively) is divided by I to calculate the resistance (R) of the right arm (R_{RA}). This process is repeated with V being recorded between E4 and the left heel electrode (E8) to obtain the resistance of the torso (R_T). The resistance of the right leg (R_{RL}) is obtained with V recorded between the right heel electrode (E6) and E8. To determine the resistance of the left arm (R_{LA}), the alternating current is applied between the electrodes at the left palm (E3) and the ball of the left foot (E7), and V is measured between E2 and E4. The resistance of the left leg (R_{LL}) is calculated from V measured between E6 and E8. Whole-body resistance (R_{sumx}) is calculated by summing the segmental resistances at frequency x, according to the following equation:

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[2] Supported by Biospace Co, Ltd, Seoul, Korea, and by Major Research Instrumentation grant no. 05-515 from the National Science Foundation.

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Received May 28, 2007.
Accepted for publication September 17, 2007.

$$R_{\text{sumx}} = R_{\text{RA}} + R_{\text{LA}} + R_{\text{T}} + R_{\text{RL}} + R_{\text{LL}} \qquad (1)$$

The index of R_{sumx} (RI$_{\text{sumx}}$) is calculated by using the following equation:

$$RI_{\text{sumx}} = \text{Ht (cm)}^2/R_{\text{sumx}}\ (\Omega) \qquad (2)$$

The frequencies used by the InBody 320 analyzer are 5, 50, and 250 kHz. Those used by the InBody 720 analyzer are 1, 5, 50, 250, 500, and 1000 kHz.

Whereas earlier octapolar BIS studies were conducted (7–10), they involved the use of small and predominantly homogenous samples. The primary thrusts of those studies were estimation validations of water compartments (7, 9) and appendicular lean tissue mass (LTM) (8, 10). No studies were found that included a racially-ethnically diverse sample or a multicomponent reference measure. Therefore, the purpose of the present study was to cross-validate the %BF estimations of the InBody 720 and InBody 320 BIS analyzers on a diverse sample of Hispanic, black, and white adults using the Selinger 4-component (4C) model (11) as the reference method.

SUBJECTS AND METHODS

Subjects

Participants were recruited by word-of-mouth and posted flyers in our South Florida community. After an initial screening through which inclusion criteria were verified, a testing appointment was scheduled. Inclusion criteria were freedom from metabolic disorders or other disease states that could affect muscle and bone, absence of surgical hardware such as pins and rods, a body mass index (BMI; in kg/m^2) that fell within an open cell in the BMI–race-ethnicity recruitment configuration, minimum age of 18 y, and absence of pregnancy. We attempted to balance the recruitment (n = 5/cell; **Table 1**), but we were unsuccessful in recruiting adults in the lowest BMI category; therefore, we overfilled other BMI categories with persons from each racial-ethnic group.

On arrival at the Human Performance Laboratory (HPL) of Barry University, participants completed a brief health history questionnaire. Participants then voided, changed into dry swimwear (or athletic shorts and tee-shirt), and removed any remaining jewelry. A wall-mounted stadiometer was utilized for barefoot, standing height (Ht) assessment; the average of 2 measures within 1.0 cm was recorded. Body mass (BM) was recorded as the average of 2 measures within 0.1 kg taken using a digital floor scale (Seca 780; Precision Weighing Balances, Bedford, IN).

TABLE 1
Final recruitment cell configuration by BMI, sex, and race-ethnicity

	≤ 18.9	19.0–22.5	23.0–26.5	27.0–30.5	≥ 31.0	Total
Men						
Hispanic	0	4	8	6	7	25
Black	0	4	10	7	4	25
White	0	6	7	7	5	25
Women						
Hispanic	1	7	6	5	6	25
Black	4	5	6	4	6	25
White	2	7	5	6	5	25
Total	7	33	42	35	32	150

All subjects gave written informed consent. The study was approved by the Institutional Review Board of Barry University.

Methods

Repeat octapolar bioimpedance analyses of each participant were obtained from the InBody 720 and InBody 320 multifrequency analyzers. In accordance with the manufacturer's guidelines, participants wiped the bottom of their feet with a proprietary electrolyte tissue before standing on the electrodes embedded in the scale platform of the respective analyzers. The participants were instructed to stand upright and to grasp the handles of the analyzer, thereby providing contact with a total of 8 electrodes (2 for each foot and hand). The participant's identification number, height, age, and sex were entered into the analyzer, and the participant was instructed to slightly abduct his or her arms and remain still during the assessment. Participants alternated between the 2 devices, wiping their feet before each trial. A participant's BM was automatically determined when he or she stood on the electrodes embedded within the scale platform of each octapolar analyzer; these weights were also recorded. The %BF was computed through the proprietary algorithms, displayed on the analyzer's control panel, and recorded. For subsequent analyses, the average %BF from the InBody 720 (%BF$_{720}$) and InBody 320 (%BF$_{320}$) was used.

TBW was measured via whole-body, multifrequency BIA (4200 Hydra; Xitron Technologies, San Diego, CA) by using the standard, tetrapolar configuration while the participant lay in a supine position on a nonconductive padded surface. The participant's arms and legs were slightly abducted to avoid contact between the arms and torso and between the upper thighs. Surface gel electrodes were positioned on the right side of the body at the wrist, hand, ankle, and foot after each site was cleaned with an alcohol pad (12). After the first measurement, the lead wire cables were disconnected from the electrodes, switched between the upper- and lower-body electrodes, and reconnected for a second measure. The average of the 2 TBW measures was recorded. BIS was selected for TBW assessment because it has been significantly ($P < 0.05$) correlated with and, on average, does not differ significantly from the measurement of TBW by isotope dilution (5, 13–15).

One whole-body dual-energy X-ray absorptiometry (DXA) scan (Prodigy Advanced Fan-Beam; General Electric, Madison, WI) using ENCORE 2005 software (version 9.30.044; General Electric) was performed by the same licensed basic X-ray machine operator while the participant was in a supine position. Bone mineral content (BMC) and %BF were recorded. Scan speed was automatically adjusted on the basis of the participant demographics entered into the computer. As previously reported (16), total BMC (TBMC) was computed by multiplying bone mineral ash by the constant 1.279.

Hydrostatic weighing (HW) was performed by using a 9-kg scale (Chatillon, Largo, FL) from which a polyvinylchloride (PVC) chair was suspended. Tare weight and water temperature were recorded before each participant's HW trials. After showering to soak their hair and swimsuit, participants entered the HW tank and received procedural instructions. The average of the heaviest 3 weights within 100 g was recorded and used for determination of body volume (Vb). Dry-land residual lung volume (RV) was measured with the helium dilution technique (Keystone^3; Ferraris Respiratory, Louisville, CO). The BM from the digital floor scale was used for net underwater weight calculations, and the average of 2 RV measures within 0.1 L was recorded and used to correct Vb values before the calculation of body density (Db). The Siri equation was used to estimate $\%BF_{HW}$ from Db (17).

Selinger's 4C model was used as the reference %BF ($\%BF_{4C}$), which was calculated according to the following equation:

$$\%BF_{4C} = [(2.747/\mathrm{Db}) - (0.714W) + (1.146M) - 2.0503] \times 100 \quad (3)$$

where Db came from HW, *W* was calculated as the ratio of TBW to BM, and *M* was calculated as the ratio of TBMC to BM. Lohman's cross-validation criteria (11) were also applied for each correlation.

Equipment was calibrated before each test session in accordance with manufacturer guidelines. The same technicians performed all measurements. All bioimpedance and HW assessments of each participant were obtained in the same session. Initially, DXA scans were performed on a separate day within 7 d of the first session to accommodate the pregnancy of one of the technicians. After delivery, all testing was performed in a single session, and HW was measured last.

Statistical analysis

For each sex, a separate race-ethnicity × method (3 × 3) repeated-measures ANOVA was calculated to assess differences between %BF measures from the various methods in our racially-ethnically diverse sample. Tukey's post hoc testing was selected to further investigate significant main effects as necessary. Simple regression analyses between the reference and 2 octapolar BIS methods were performed to assess the correlation between methods. Potential methodologic bias was further investigated by using the Bland-Altman technique (18). All analyses were performed with SPSS-PC software (version 10; SPSS Institute, Chicago, IL); significance was set at $P < 0.05$.

RESULTS

The descriptive characteristics of the sample ($N = 150$) are shown in **Table 2**. Equal numbers of men and women from each racial-ethnic category were recruited. Three volunteers (1 black woman, 1 Hispanic woman, and 1 Hispanic man) were unable to perform the HW maneuver, and 1 black man's gross underwater weight exceeded the capacity of the Chatillon scale; therefore, data for these 4 participants were excluded from %BF comparisons.

The results of the test-retest (duplicate assessments per participant) reliability of %BF from each octapolar analyzer indicated a strong intraclass correlation [(ICC) ie, 0.9995] between trials of the InBody 720 but a mean difference of 0.10%BF that was significant (26.58 ± 11.04 compared with 26.68 ± 11.04%BF; $P < 0.05$) in the entire sample ($n = 150$). For the InBody 320, the test-retest results also showed a strong ICC (ie, 0.9964) but no significant difference between means (26.88 ± 10.92 compared with 26.94 ± 11.06%BF; $P > 0.05$).

Relative body fat values for each method and in each racial-ethnic group are shown, by sex, in **Table 3**. Results from the 3 × 3 repeated-measures ANOVA indicated that, in the men, there

TABLE 2
Descriptive characteristics of the sample

	Minimum	Maximum	Value
Men ($n = 75$)			
Age (y)	18.0	82.0	30.62 ± 13.63[1]
Height (cm)	107.2	195.0	177.69 ± 11.32
Weight (kg)	60.5	164.6	88.18 ± 18.76
BMI (kg/m^2)	20.1	50.4	27.60 ± 18.76
Women ($n = 75$)			
Age (y)	18.6	67.6	33.10 ± 12.90
Height (cm)	148.5	192.4	164.90 ± 8.71
Weight (kg)	37.3	135.0	71.59 ± 17.62
BMI (kg/m^2)	16.8	54.7	26.30 ± 6.35

[1] $\bar{x}$ ± SD (all such values).

TABLE 3
Percentage body fat values by method and sex for white, black, and Hispanic adults[1]

Method and racial-ethnic group	Value
Men ($n = 73$)	
Selinger's 4C	
White	23.84 ± 8.28[2]
Black	18.12 ± 8.82
Hispanic	22.01 ± 10.02
Total	21.34 ± 9.25
InBody 720	
White	21.71 ± 8.39
Black	17.78 ± 7.54
Hispanic	23.41 ± 9.87
Total	20.98 ± 8.85
InBody 320	
White	21.58 ± 8.18
Black	18.13 ± 7.14
Hispanic	23.33 ± 9.69
Total	21.02 ± 8.56
Women ($n = 73$)	
Selinger's 4C	
White	33.99 ± 8.82
Black	34.79 ± 8.58
Hispanic	36.39 ± 9.81
Total	35.04 ± 9.01
InBody 720	
White	31.76 ± 9.74
Black	30.48 ± 10.48
Hispanic	33.94 ± 9.31
Total[3]	32.05 ± 9.82
InBody 320	
White	31.41 ± 9.66
Black	31.93 ± 10.01
Hispanic	34.36 ± 9.11
Total[3,4]	32.55 ± 9.55

[1] $n = 146$. 4C, 4-component model; InBody 720 and InBody 320, bioimpedance spectroscopy analyzers (Biospace Co Ltd, Seoul, Korea). Results are from the application of separate, sex-specific, 3 (method) × 3 (race-ethnicity) repeated-measures ANOVA with Tukey's post hoc testing as applicable. For each sex, there were 25 white, 24 black, and 24 Hispanic participants. There were no significant method × race-ethnicity interactions in the women.

[2] $\bar{x}$ ± SD (all such values).

[3] Method significantly different from Selinger's 4C model in women, $P < 0.05$.

[4] Method significantly different from InBody 720 in women, $P < 0.05$.

TABLE 4
Results from methodologic correlations against Selinger's 4C reference method for percentage body fat[1]

Method	$r_{y,y'}$	SEE	%SEE	E	Δ	Slope[2]	Intercept[3]	$r_{y,\mathrm{res}}$
Men (n = 73)								
InBody 720	0.843[4]	5.1899	24.32	5.0707	0.2295	0.8804	2.8903	0.14
InBody 320	0.842[4]	5.1657	24.21	5.0272	0.1977	0.9097	2.2353	0.19
Women (n = 73)								
InBody 720	0.884[4]	4.8488	13.84	5.4566	2.9908[4]	0.8119	9.0206	−0.18
InBody 320	0.892[4]	4.8204	13.76	4.9913	2.4928[4]	0.8412	7.6607	−0.13

[1] 4C, 4-component model; $\%BF_{4C}$, percentage body fat in Selinger's 4C model; $r_{y,y'}$, correlation coefficient between $\%BF_{4C}$ and estimated value; SEE, standard error of estimate [SDy $\sqrt{(1-r^2_{y,y'})}$]; %SEE, 100 × (SEE/mean $\%BF_{4C}$); E, total error $\{\sqrt{[\Sigma\,(y-y')^2/N]}\}$; Δ, =mean $\%BF_{4C}$ − mean estimated value; $r_{y,\mathrm{res}}$ = correlation coefficient between the average of 2 estimates and residual scores.

[2] Each value in the column is significantly different from 1.0, $P < 0.05$.

[3] Each value in the column is significantly different from 0.0, $P < 0.05$.

[4] $P < 0.05$.

were no significant within- or between-subjects effects; therefore, data were not further analyzed for method × race-ethnicity interaction effects. Simple regression analyses performed against $\%BF_{4C}$ produced significant correlation coefficients (**Table 4**) for both $\%BF_{720}$ and $\%BF_{320}$, which are shown in **Figure 1**A and **Figure 2**A, respectively. The results of the Bland-Altman analyses indicated no significant or systematic overestimation or underestimation of $\%BF_{4C}$ at the extremes of the distribution for $\%BF_{720}$ (Figure 1B) or $\%BF_{320}$ (Figure 2B). For the InBody 720, $\%BF_{4C}$ was underestimated for 33 of the 73 men (45%), whereas the InBody 320 underestimated $\%BF_{4C}$ for 48% of our sample. The reference %BF of 69 men was estimated within ± 2SD by both of the octapolar BIS analyzers.

In the women, there was a significant within-subjects effect for method but no between-subjects effect for race-ethnicity; there was no significant method × race-ethnicity interaction (Table 3). Simple regression analyses performed against $\%BF_{4C}$ produced significant correlations for $\%BF_{720}$ (**Figure 3**A) and $\%BF_{320}$ (**Figure 4**A) (Table 4). As was found in the men, the Bland-Altman results in the women indicated no significant or systematic overestimation or underestimation of $\%BF_{4C}$ at the extremes of the distribution for $\%BF_{720}$ (Figure 3B) or $\%BF_{320}$ (Figure

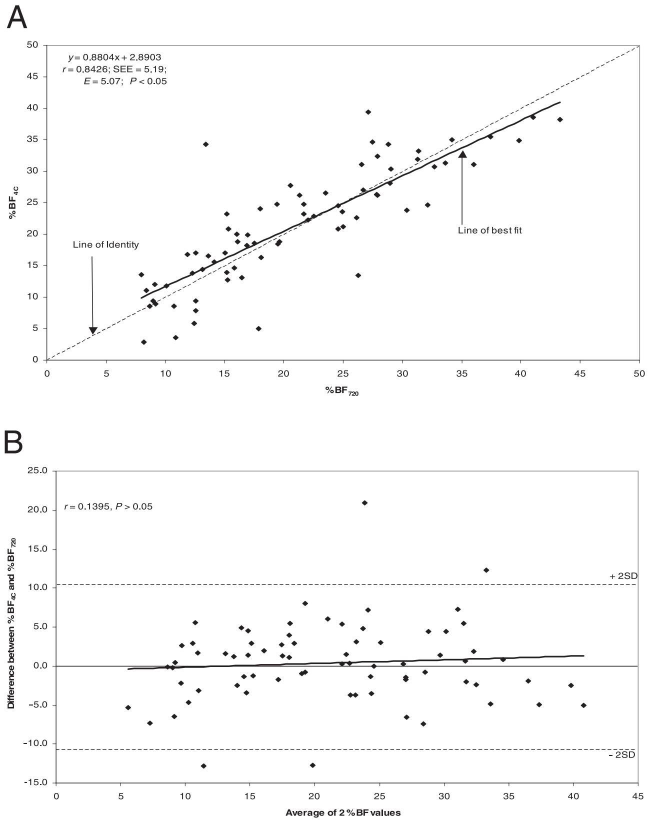

FIGURE 1. A: Correlation between percentage body fat in Selinger's 4-component model ($\%BF_{4C}$) and in the InBody 720 device ($\%BF_{720}$) in men (n = 73). B: Bland-Altman plot of $\%BF_{4C}$ and $\%BF_{720}$ in men. – – –, ± 2SD from a mean difference of 0.0.

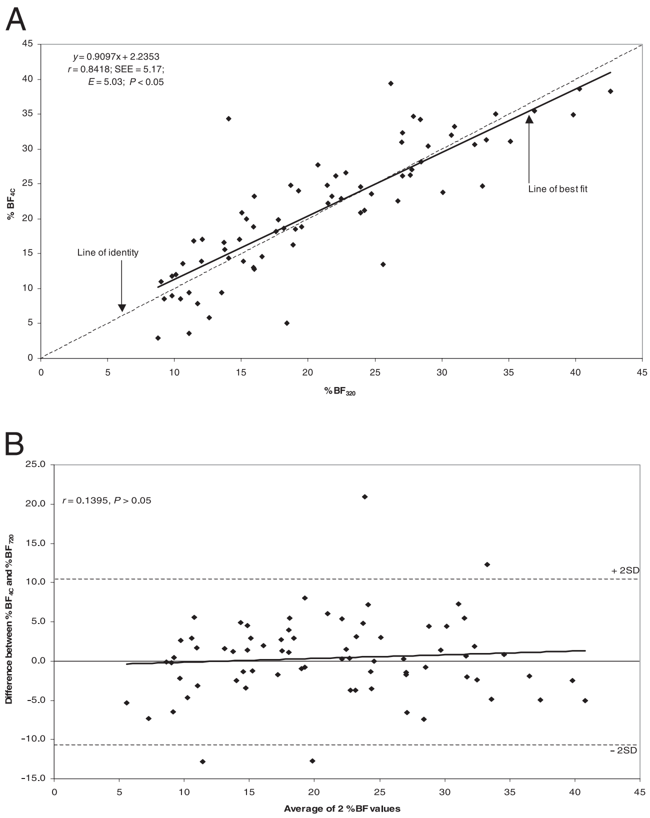

FIGURE 2. A; Correlation between percentage body fat in Selinger's 4-component model ($\%BF_{4C}$) and in the InBody 320 device ($\%BF_{320}$) in men (n = 73). B: Bland-Altman plot of $\%BF_{4C}$ and $\%BF_{320}$ in men. – – –, ± 2SD from a mean difference of 0.0.

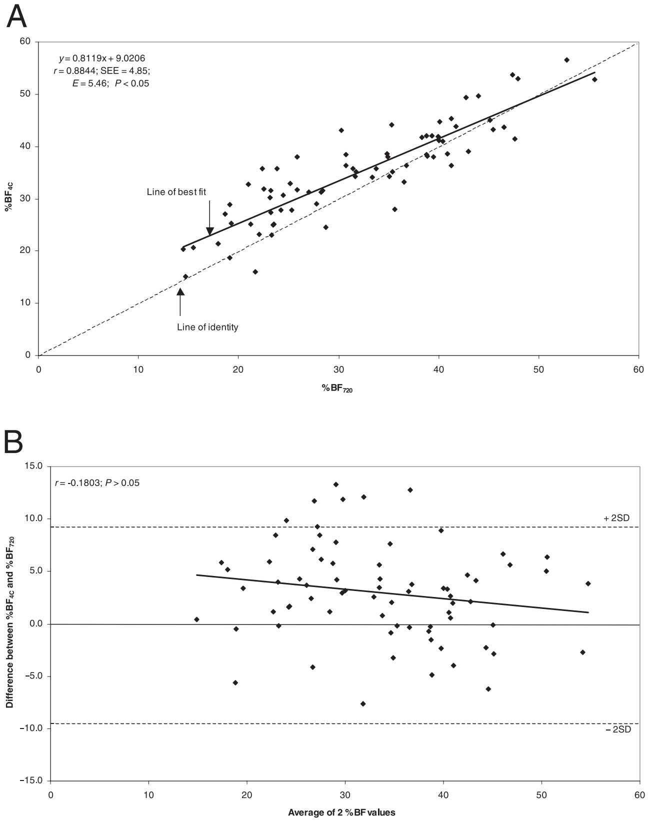

FIGURE 3. A: Correlation between percentage body fat in Selinger's 4-component model ($\%BF_{4C}$) and in the InBody 720 device ($\%BF_{720}$) in women ($n = 73$). B: Bland-Altman plot of $\%BF_{4C}$ and $\%BF_{720}$ in women. – – –, ± 2SD from a mean difference of 0.0.

4B). The $\%BF_{4C}$ was underestimated by 2.99%BF with the InBody 720 and by 2.5%BF with the InBody 320 ($P < 0.05$ for both). Although the mean difference between the 2 octapolar analyzers was only 0.5%BF, the difference was significant ($P < 0.05$). The $\%BF_{4C}$ was estimated within ± 2SD in all but 6 women. The reference measure was overestimated by $\%BF_{720}$ and $\%BF_{320}$ in 73% and 74% of the women, respectively.

Neither the InBody 720 nor the InBody 320 satisfied Lohman's 1992 cross-validation criteria. Whereas correlations with the reference measure were significant and $r \geq 0.80$, the SEEs and Es (total error) exceeded 3.5%BF. In addition, the slopes and intercepts of the lines of best fit were significantly different from 1.0 and 0.0, respectively; however, mean methodologic differences existed in the women only.

DISCUSSION

The $\%BF_{720}$ and $\%BF_{320}$ values were significantly and strongly correlated to the reference $\%BF_{4C}$ measures in both sexes in our heterogeneous sample. In the men, there were no significant methodologic differences in %BF estimation, whereas, in the women, $\%BF_{4C}$ was significantly underestimated by ≈2.5–3.0%BF by each InBody analyzer. When we applied the cross-validation criteria of Lohman (11), the magnitude of the SEEs and Es (Table 4) was higher than desired in men (<3.5%BF) and women (<2.8%BF). Perhaps this is due to the heterogeneity of our sample, to the slightly different BM values used for %BF calculations, or to our use of dry-land RV measures and TBW from the Xitron in our reference method calculations.

Investigation of potential methodologic bias in estimating $\%BF_{4C}$ showed that there was none at the extremes of the distributions (Figures 1B, 2B, 3B, and 4B). There was a sex-specific overestimation of $\%BF_{4C}$. Each octapolar device overestimated $\%BF_{4C}$ in approximately two-thirds of the women. Therefore, the predictive accuracy of these 2 octapolar BIS analyzers appeared to be better in the men in the present study. Conversely, the SEEs (Table 4) were somewhat better and the correlations stronger in the women than in the men.

Comparison of our %BF findings with those from earlier InBody studies is difficult, because none used a multicomponent reference measure; when FFM or %BF was provided, it was usually part of the descriptive characteristics of the sample. Moreover, when FFM comparisons were made, they were between a clinical subgroup and apparently healthy controls (8). Malavolti et al (10) reported a comparison of FFM differences between BIS (48.0 ± 9.7 kg) and their DXA (Lunar DPX-L software version 3.6; Lunar Corporation, Madison, WI) reference (48.0 ± 10.1 kg). Statistical comparison of the sample in the study by Malavolti et al, which was similar in age to the participants in the current study, showed a root mean square error of 2.8 kg or 6% for the entire sample, but not for each sex separately. The reporting by Malavolti et al of a small FFM difference is supported by our failure to find a significant difference when comparing the octapolar %BF values with our reference $\%BF_{4C}$ in the men in the present sample.

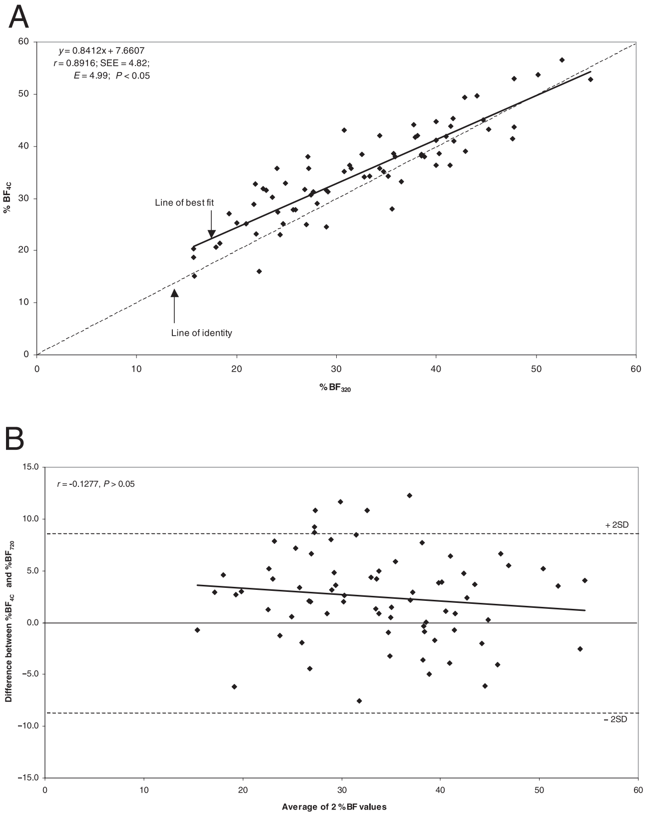

FIGURE 4. A: Correlation between percentage body fat in Selinger's 4-component model ($\%BF_{4C}$) and in the InBody 320 device ($\%BF_{320}$) in women ($n = 73$). B: Bland-Altman plot of $\%BF_{4C}$ and $\%BF_{320}$ in women. – – –, ± 2SD from a mean difference of 0.0.

Three of the 150 volunteers were unable to perform the HW procedure because of the psychological discomfort associated with submerging their heads. Nevertheless, we cannot exclude the possibility that some of the participants failed to give the same maximal exhalation effort during the HW trials as they gave during the dry-land RV trials. To investigate this further, we used the Xitron TBW to compute %BF (%BF_{Xitron}) on the basis of the assumed hydration (73%) of FFM (19). We computed %BF from underwater weighing and the Siri conversion formula (%BF_{Siri}) and performed separate, sex-specific 2 (method %BF_{Xitron} or %BF_{Siri}) by 3 (race-ethnicity) repeated-measures ANOVAs. In the men (%BF_{Xitron}: 21.21 ± 10.70%BF; %BF_{Siri}: 20.78 ± 10.14%BF), within-subjects effects for method or race-ethnicity were nonsignificant. In the women, the within-subjects effect for method was significant; %BF_{Xitron} (35.70 ± 7.69%BF) was significantly ($P < 0.05$) higher than %BF_{Siri} (31.98 ± 11.04%BF). There were no significant between-subjects or interaction effects in the women. Possible explanations for these findings may be a sex-specific ability to meet the assumptions underlying the 2-compontment (2C) model and our use of the Siri conversion formula for the women in our study. In any case, the ICCs (%BF_{Xitron} compared with %BF_{Siri}) in the men (0.72) and women (0.86) were significant ($P < 0.05$).

Noncompliance was not an issue when the octapolar devices were used. Compared with the time required to perform the requisite number of RV and HW trials, the 2- min InBody trial was very short. Futhermore, although they are beyond the scope of this study, the results output from the octapolar analyzers was extensive as well as immediate. Therefore, the use of these vertical BIS devices may be suitable for facilities and practitioners performing body-composition assessments in a diverse, ambulatory clientele of adults who are capable of grasping handles and abducting their arms. These analyzers eliminate the technician-dependent errors and privacy issues associated with skinfold thickness assessment. The InBody analyzers may account for appendicular muscular dysymmetry more accurately than do other BIA techniques. Malavolti et al (10) reported good agreement between DXA and an earlier InBody model (InBody 3.0) when assessing appendicular LTM in a sample of white women and men with BMIs ranging from 18.5 to 33.8. Bedogni et al (7) commented on differences between the LTM of their participants' right and left arms according to InBody 3.0 impedance values. Implications of the finding of Bedogni et al extend to traditional tetrapolar BIA, because the extent of muscular development (side dominance) affects the resistance to the electrical currents passing through the appendages—ie, the more muscular the appendage, the lower the resistance—and, hence, assumptions about appendicular contribution to body fatness.

Bedogni et al (7) performed repeated measures using the InBody 3.0 3 times/d for 5 consecutive days with their participants in a fasted state. They reported a precision based on resistance (R) that was ≤ 2.8% for all body segments and frequencies. Whereas we found very high InBody %BF test-retest reliability, our investigation of the significant mean %BF difference in the InBody 720 trials found that the source of the difference appeared to be sex-specific. There was no significant mean %BF difference between the 2 trials in the men (20.96 ± 8.88 and 21.00 ± 8.83%BF in the InBody 720 trials; $P > 0.05$); however, there was a clinically small, but significant mean difference in the women's test-retest data (32.35 ± 9.97 and 32.50 ± 9.94%BF in the InBody 720 trials; $P < 0.05$). Because BM is not keyed into the octapolar BIS devices, we further investigated potential BM differences as automatically determined when the participant stood on the analyzer's scale platform where the electrodes were embedded. In the whole sample, there was no significant difference between test-retest BM values (79.87 ± 18.96 and 79.84 ± 18.96 kg in the InBody 720 and InBody 320 trials, respectively), nor were there significant BM differences between the 2 sexes. Therefore, the difference in our %BF reliability investigation of the InBody 720 may be explained by a slight alteration in the handgrip tension or degree of participant arm abduction when the participant is holding the handles that are connected to the analyzer via flexible cables. The InBody 320 handles are connected to that analyzer via stiff rods, which minimizes trial-to-trial deviation in the angle of arm abduction. It is tempting to accept this explanation, but doing so implies there is a sex difference in the ability to duplicate an abducted arm position and maintain it for ≈2 min.

In summary, the strength of correlations with the %BF_{4C} reference and the lack of significant methodologic mean differences in the men suggest the promise of this technology for assessment of %BF in apparently healthy men such as those in the present sample. In the women, the correlations were slightly stronger between methods, but there also were significant differences between means and a greater tendency of the new BIS devices to overestimate %BF_{4C}. It appears that the body-composition assessment of the black women presented a greater challenge for the 2 octapolar devices than did that of the white and Hispanic women and that our use of the Siri conversion formula for the black women may have introduced error into the calculation of their %BF_{4C}. Regardless, the small machine footprint, the high test-retest reliability, and the expediency with which analyses can be conducted with minimal participant involvement suggest that these devices may be suitable for tracking body composition over time. Nevertheless, to increase the accuracy of BIA results, it is imperative that the participants receive and follow standard pretest guidelines (12).

The authors' responsibilities were as follows—ALG: study design; all authors: data collection and participant recruitment; LN: assistance with data entry; ALG: wrote and revised the manuscript; and all authors: reviewed and critiqued the manuscript. None of the authors had a personal or financial conflict of interest.

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