TACSM Abstract

Validity of Four-Compartment Model Body Fat Using Single- or Multi-frequency Bioelectrical Impedance Analysis to Estimate Body Water

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ABSTRACT

Most common body composition assessment techniques make assumptions about the body, including the density and hydration of fat-free mass (FFM). An advantage of the four-compartment (4C) model is the ability to take these FFM characteristics into account when assessing body composition, thus reducing potential error. The total body water (TBW) estimate utilized in 4C models is particularly important due to the large contribution of water to an adult human's total body mass (~40 - 70%) and FFM (~68 - 81%); however, the impact of utilizing different estimates of TBW within 4C model has not been fully explored. **PURPOSE**: The purpose of this investigation was to examine the validity of body fat percentage (BF%) estimates produced by 4C models utilizing single- or multi-frequency bioelectrical impedance analysis (BIA) TBW estimates as compared to a criterion 4C with TBW from bioimpedance spectroscopy (BIS). **METHODS**: After an overnight food and fluid fast, a sample of 101 adults (63 F, 38 M; age: 29.3 ± 13.5 y; BMI: 24.3 ± 4.0 kg/m^2; BF%: 24.5 ± 8.3%) completed assessments via dual-energy x-ray absorptiometry (DXA), air displacement plethysmography (ADP), BIS, single-frequency BIA (SFBIA), multi-frequency BIA (MFBIA) and a body mass scale. A criterion 4C model ($4C_{BIS}$) estimate of BF% was obtained using DXA for bone mineral, ADP for body volume, scale for body mass, and BIS for TBW. BIS was used as the reference TBW method due to its more direct estimation of TBW via mathematical procedures (i.e. Cole modeling and mixture theories) as compared to the prediction equations used by BIA. Alternate 4C estimates of BF% were produced using TBW values from MFBIA ($4C_{MFBIA}$) and SFBIA ($4C_{SFBIA}$). BF% estimates were compared using one-way ANOVA, and additional evaluations were conducted using the coefficient of determination (R^2), constant error (CE), total error (TE), and 95% limits of agreement (LOA). **RESULTS**: BF% did not differ between $4C_{BIS}$ (24.5 ± 8.3%), $4C_{MFBIA}$ (24.4 ± 8.9%), and $4C_{SFBIA}$ (25.7 ± 8.3%; p=0.52). $4C_{MFBIA}$ exhibited negligible CE (-0.1 ± 2.3%), R^2 of 0.97, TE of 2.3%, and LOA of 4.4%. $4C_{SFBIA}$ exhibited a small CE (1.2 ± 1.2%), R^2 of 0.98, TE of 1.6%, and LOA of 2.3%. **CONCLUSION**: At the group level, BF% estimates did not differ between any 4C model, indicating that both SFBIA and MFBIA can serve as viable alternatives to BIS for TBW estimation. Although the magnitude of group error (i.e. CE) was slightly smaller in $4C_{MFBIA}$, the individual error (i.e. LOA) and total error were smaller in $4C_{SFBIA}$, indicating that SFBIA TBW estimates may be more appropriate when tracking body composition changes within individuals using a 4C model. While the MFBIA and SFBIA technologies employed in the present study exhibited good validity, these results may not be attributable to all BIA analyzers. The quality of assessment device, affordability, portability and ease of use should be considered when utilizing an impedance-based technology for TBW estimation in a 4C model.