TACSM Abstract

A Between-sex Comparison of the Validity of Body Fat Percentage Estimates From Four Bioelectrical Impedance Analyzers

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ABSTRACT

Bioelectrical impedance analysis (BIA) devices administer electrical currents through surface electrodes in contact with the hands and/or feet. The measured reactance and resistance of various bodily tissues to these currents are then used to estimate body fat percentage (BFP) and other body composition values of interest based on algorithms derived from validation data. Owing to different patterns of fat distribution between sexes, it is unclear whether the configuration of electrodes (i.e., hand-to-hand, foot-to-foot, or hand-to-foot) may affect the validity of these devices in males versus females. **PURPOSE**: The purpose of this study was to determine the validity of BFP values across four BIA devices – one consumer-grade foot-to-foot device (RENPHO Smart Bathroom Scale), one consumer-grade hand-to-hand device (Omron HBF-306), one consumer-grade octapolar device (InBody H20N), and one research-grade octapolar device (Seca mBCA 515/514) – against a criterion four-compartment model (4C), and to compare these values between males and females. **METHODS**: Seventy-four healthy participants (35 males and 39 females) were included in this analysis. Participants abstained from all food, fluid, caffeine, and alcohol for at least 8 hours prior to each visit. Total error (TE) was calculated as the root mean square error between the estimate of each BIA device and that of the 4C model. Standard error of the estimate (SEE) was defined as the residual standard error value from ordinary least squares regression. Constant error (CE) was calculated as the average difference between the estimate of each BIA device and that of the 4C model. **RESULTS**: Participants had a mean ±SD age of 27.2 ±7.3 years, height of 168.1 ±8.9 cm, weight of 72.2 ±16.7 kg, and 4C BFP of 24.9 ±9.2%. In the entire sample, ranges for validity metrics of interest were as follows: TE: 3.2% (Seca) to 7.2% (RENPHO); SEE: 3.3% (Seca) to 5.7% (RENPHO); CE: -0.02 ±3.4% (InBody) to -3.46 ±4.1% (Omron). Across all devices, both TE and SEE were lower in females, with the largest between-sex differences observed for the InBody and RENPHO. Both octapolar devices (InBody and Seca) exhibited low group-level error in males and females (all CE within ±0.32%). Meanwhile, the RENPHO and Omron devices generally underestimated BFP with a greater degree of underestimation in females (CE of -2.6% and -3.7%, respectively) than males (CE of -0.1% and -3.2%, respectively), particularly for the RENPHO. **CONCLUSION:** Among the four BIA devices investigated, octapolar devices tended to have higher validity overall. All devices demonstrated lower TE and SEE in females, with the greatest between-sex differences observed in the InBody and RENPHO models. Users should be aware that commercially available hand-to-hand or foot-to-foot BIA devices such as the Omron and RENPHO models used in this study may systematically underestimate BFP compared to a criterion 4C model. In contrast, hand-to-foot octapolar analyzers exhibit strong group-level validity in both sexes.