Urine Specific Gravity Effect on Total and Segmental Body Composition Validity of Multifrequency Bioelectrical Impedance Analysis Compared with Dual Energy X-Ray Absorptiometry

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Abstract
Fleck, SJ, Hayes, A, Stadler, G, Goesch, T, Goldammer, M, and Braun, S. Urine specific gravity effect on total and segmental body composition validity of multifrequency bioelectrical impedance analysis compared with dual energy x-ray absorptiometry. J Strength Cond Res 35(2): 373–384, 2020—The purposes were to compare body composition measures between a specific multifrequency bioelectrical impedance analyzer (InBody770) and dual-energy x-ray absorptiometry (DXA) and determine if hydration status within a specified range affected these measures. Methodology included determining urine specific gravity before testing. The sample was divided into 3 hydration groups: well-hydrated (n = 37), euhydrated (n = 45), and slightly dehydrated (n = 37). Segmental and total body composition measures were determined with the InBody770 and DXA with the same testing session. Paired sample t-tests revealed significant differences (p < 0.005) between InBody770 and DXA for all body composition variables for all 3 hydration statuses, except for trunk fat-free mass (FFM) and trunk fat mass (FM) of the well-hydrated and euhydrated groups and right leg FM and trunk FFM of the slightly dehydrated group. For the total sample (n = 102), InBody770 significantly underestimated total body FM, right arm FM, left arm FM, right leg FM, and left leg FM with an underestimation bias between 0.16 and 2.80 kg. The total body FM by InBody770 was overestimated by 2.31 ± 2.80 kg for 3.6%. Bland-Altman plots supported these results. The major conclusions are that differences between the InBody770 and DXA segmental and total body composition measures are generally significantly different.

Key Words: hydration status, body composition, dual energy x-ray absorptiometry, multifrequency bioelectrical impedance analyzer

Introduction
Body composition is commonly sought in health, medical, fitness, and sport research. Typically, total body measures such as fat mass (FM), fat-free mass (FFM), and bone mass have been measured. Advances in technology now allow segmental body composition such as arm, leg, and trunk body composition. Two technologies that can assess total and segmental body composition are dual-energy x-ray absorptiometry (DXA) and multifrequency bioelectrical impedance analysis (MFBIA). Dual-energy x-ray absorptiometry determination of body composition is expensive, is primarily found in laboratory and clinical settings, requires a trained technician, involves exposure to low-level radiation, is not portable, and is inconvenient for use in large populations or large interventional studies. Multifrequency bioelectrical impedance analysis has become popular in laboratory and field settings to test athletes, fitness enthusiasts, and other populations because it has no radiation exposure, requires less training, is inexpensive, and is easier to use compared with DXA. MFBIA is an electrical impedance technique that uses a constant current to measure impedance and determine body composition (19) and has been used as a reference standard to valid MFBIA measures of body composition. Validation studies have shown strong correlations between DXA and MFBIA total and segmental body composition measures in adult cohorts (2,27,33), female collegiate athletes (3), and male collegiate athletes (3). Despite the strong correlations between body composition measures determined by DXA and MFBIA, studies have shown significant differences between DXA and MFBIA in total (2,27,33) and segmental body composition measures in adults (2,27,33). Significant differences between these 2 methodologies have also been shown in collegiate athletes in total (17,27) and segmental body composition measures (3,24). The aforementioned studies comparing the accuracy of MFBIA with DXA did not examine the possible effect of hydration that may affect body composition measures of both methodologies. Differences between DXA and MFBIA in body composition measures may be due to several factors. It has been reported that the higher FFM and lower FM results may result in less accurate body composition estimates by MFBIA compared with DXA (15). In addition, with increasing FM, the underestimation of FM by MFBIA increases (17,24). The aforementioned studies comparing the accuracy of MFBIA with DXA did not examine the possible effect of hydration that may affect body composition measures of both methodologies. Differences between DXA and MFBIA in body composition measures may be due to several factors. It has been reported that the higher FFM and lower FM results may result in less accurate body composition estimates by MFBIA compared with DXA (15). In addition, with increasing FM, the underestimation of FM by MFBIA increases (17,24). The aforementioned studies comparing the accuracy of MFBIA with DXA did not examine the possible effect of hydration that may affect body composition measures of both methodologies. Differences between DXA and MFBIA in body composition measures may be due to several factors. It has been reported that the higher FFM and lower FM results may result in less accurate body composition estimates by MFBIA compared with DXA (15). In addition, with increasing FM, the underestimation of FM by MFBIA increases (17,24). The aforementioned studies comparing the accuracy of MFBIA with DXA did not examine the possible effect of hydration that may affect body composition measures of both methodologies.

Sabbatical Research:
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One paper my colleagues and I were able to publish during my sabbatical was the validation study of a non-invasive, relatively inexpensive instrument that measures region-specific body composition. Because this instrument relies on bioelectrical impedance (how much resistance there is for electrical activity to pass through the body), hydration level could influence its accuracy in estimating fat-free mass. We found that being in slightly dehydrated or slightly over-hydrated state did not influence the accuracy of this body composition instrument, meaning in a practical setting, researchers could allow for a slightly wider range of hydration status among participants prior to measurement.