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Sabbatical Research:

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

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.

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, 2021—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. Methods included determining urine specific gravity before testing. Urine specific gravity needed to be within typical well-hydrated ($n = 37$), euhydrated ($n = 45$), or slightly dehydrated ($n = 20$) ranges. Segmental and total body composition measures were determined with the InBody770 and by DXA within 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 FFM, left arm FFM, right leg FFM, and left leg FFM with the range of underestimation being between 0.16 and 2.87 kg. The total body FFM by InBody770 was overestimated by 2.33 ± 2.80 kg or 3.6%. Bland-Altman plots supported these results. The major conclusions are that differences between the InBody770 and DXA segmental and total body FFM and FM are not significantly affected by hydration status in the range investigated, and the FM and FFM determined by the 2 devices are generally significantly different.

Key Words: fat-free mass, fat mass, percent body fat

Introduction

Body composition is commonly assessed 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 access 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. Dual energy x-ray absorptiometry is believed to be a criterion measure in determining body composition (19) and has been used as a reference standard to validate MFBIA estimates 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 (3,7), 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 (2,33). Significant differences between these 2 methodologies have also been shown in collegiate athletes in total (3,7,24) 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 in athletes may result in less accurate body composition estimation by MFBIA compared with DXA (3). In addition, with increasing FM, the underestimation of FM by MFBIA increases compared to DXA (15,20), and higher FM results in increased differences between DXA and MFBIA for FFM and FM (24). The aforementioned observations may be related to the underlying assumption of MFBIA (18,27,31) and DXA (17,27) that approximately 73% is a constant for the hydration of FFM. Although 73% is a constant for hydration for FFM in adults (22,32) increased muscle mass would increase FFM hydration because muscle mass has a water content of 80% in

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