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The Comparison of Dual-Energy X-Ray Absorptometry (DXA) and Bioelectrical Impedance Analysis (BIA) in Measuring Body Composition

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Introduction

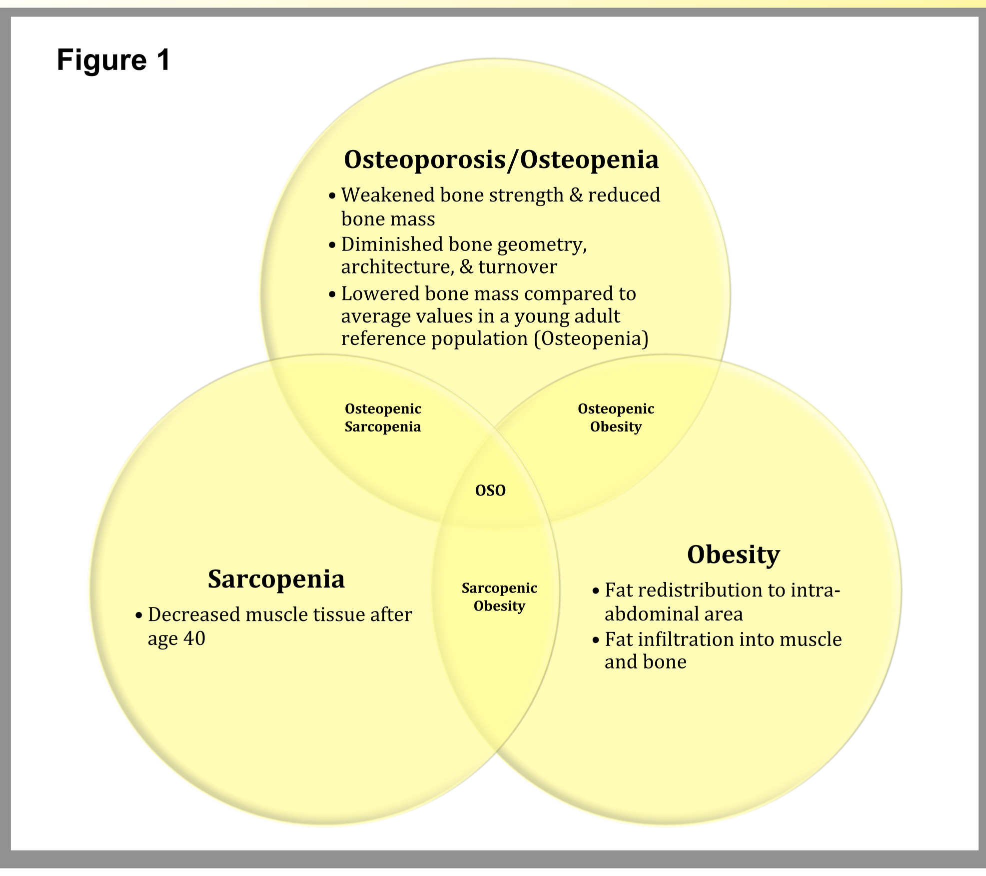

Figure 1. Three conditions present in the older female population are shown above. The diagram highlights the relationships between these conditions. The newly discovered condition, Osteosarcopenic obesity (OSO) is shown as the triad of Osteoporosis, Sarcopenia, and Obesity.

In recent studies the codependences of bone, fat, and muscle in older populations of women have been highlighted. **Figure 1** illustrates the relationships between bone, fat, and muscle in older populations of women. Ilich and colleges worked to consolidate the terms osteopenic obesity and sarcopenic obesity into a condition known as osteosarcopenic obesity (Ilich et al., 2014).

Due to the overlap and relatively new knowledge of these conditions, it is crucial to understand the methods of analyzing body composition. When measuring body composition, particularly lean mass and fat mass as well as bone density, there are several diagnostic approaches that can be taken. Magnetic resonance imaging (MRI) and computerized tomography (CT) provide reliable measurements. However, these methods are costly and expose the patient to radiation. Duel-energy X-ray absorptiometry (DXA) has become an alternative method (Chien, Huang, & Wu, 2008). Duel-energy X-ray absorptiometry is now one of the most accurate methods of evaluating body composition (Huang et al., 2015). In recent years Bioelectrical Impedance Analysis (BIA) has become a desirable substitute to the previously mentioned methods because it is cost effective as well as portable (Franco-Villoria, Wright, McColl, Sherriff, & Pearce, 2016).

This study aims to assess the accuracy of Bioelectrical Impedance Analysis (BIA) compared to Dual-energy X-ray absorptiometry (DXA) output through statistical analyses. The hypothesis is that although DXA is the gold standard for body composition readings, BIA serves as a good alternative for body composition analysis. In addition, the predictability of osteosarcopenic obesity and its related conditions will be assessed through statistical analyses of lean mass, fat mass, and bone density.

Abstract

Assessments of body composition have become increasingly important in older adults. Osteosarcopenic obesity (OSO), for example, is a recently recognized condition, seen predominately in older women, which involves a combination of bone loss (osteoporosis), loss of lean mass and strength (sarcopenia), and increased body fat. Although conditions such as osteoporosis have been acknowledged, the combined conditions, such as in OSO, are not sufficiently examined. The aim of this study was to compare methods of analyzing body composition, in an effort to better identify conditions which alter body composition. Researchers analyzed body composition in Caucasian women over the age of 65 years old. Dual-Energy X-Ray Absorptiometry (DXA) measurements of total lean mass (TLM), appendicular (arms and legs) lean mass (ALM), body fat (BF), and percent body fat were compared to measurements taken using Bioelectrical Impedance Analysis (BIA). Data was analyzed using SPSS statistical software. Results indicated significant differences in BF_{DXA} and BF_{BIA}. Differences were not significant for ALM_{DXA} and ALM_{BIA}, as well as TLM_{DXA} and TLM_{BIA}. The hypothesis that BIA is a reliable predictor of body composition was partially supported. However, conclusions should be made cautiously due to small sample sizes.

Methods & Measures

BIA

- Total lean mass (including organ and heart muscle), fat mass, and resistance were measured.
- Electrodes were placed in a hand-to-foot mode with the participant lying in the supine position.
- Appendicular lean mass (ALM) (excluding organ and heart muscle) was calculated from the BIA data using the formula below where height is in cm; resistance is in ohms; for sex, men = 1 and women = 0; and age is in years:

ALM (kg) = [0.401 x (height2/ resistance) + (3.825 x gender) - (0.071 x age) + 5.102]

DXA

- Total lean mass, arm and leg lean mass, total fat mass, and arm and leg fat mass were measured.

Anthropometrics

- Height (cm) and weight (kg) were measured.

Statistical Analysis

- All data were analyzed using IBM SPSS Statistics 22 software.
- Descriptive statistics were run for all data
- Pearson correlation coefficients were calculated to determine the correlation between BF_{DXA} and BF_{BIA}, ALM_{DXA} and ALM_{BIA}, as well as TLM_{DXA} and TLM_{BIA}.
- Paired *t* tests compared the means.

Results

The Pearson correlation coefficients, shown in **Figure 2a and 2b**, for BF_{DXA} and BF_{BIA}, ALM_{DXA} and ALM_{BIA}, as well as TLM_{DXA} and TLM_{BIA} showed moderate correlations with the r^2 values equaling 0.482, 0.412, and 0.595 respectively. The weaker correlation between the ALM_{DXA} and ALM_{BIA} is likely due to ALM_{BIA} only being calculated for a 13 of the 24 participants. Although the TLM values include the musculature of the heart and visceral organs, it points to a stronger relationship between lean body mass results from the BIA and the DXA in small sample sizes. Paired *t* tests for BF_{DXA} and BF_{BIA} showed the differences in the means were significant (p = 0.016). Paired *t* tests for ALM_{DXA} and ALM_{BIA} showed the differences in the means were not significant (p = 0.184). Differences in means were also not significant for TLM_{DXA} and TLM_{BIA} (p = 0.094).

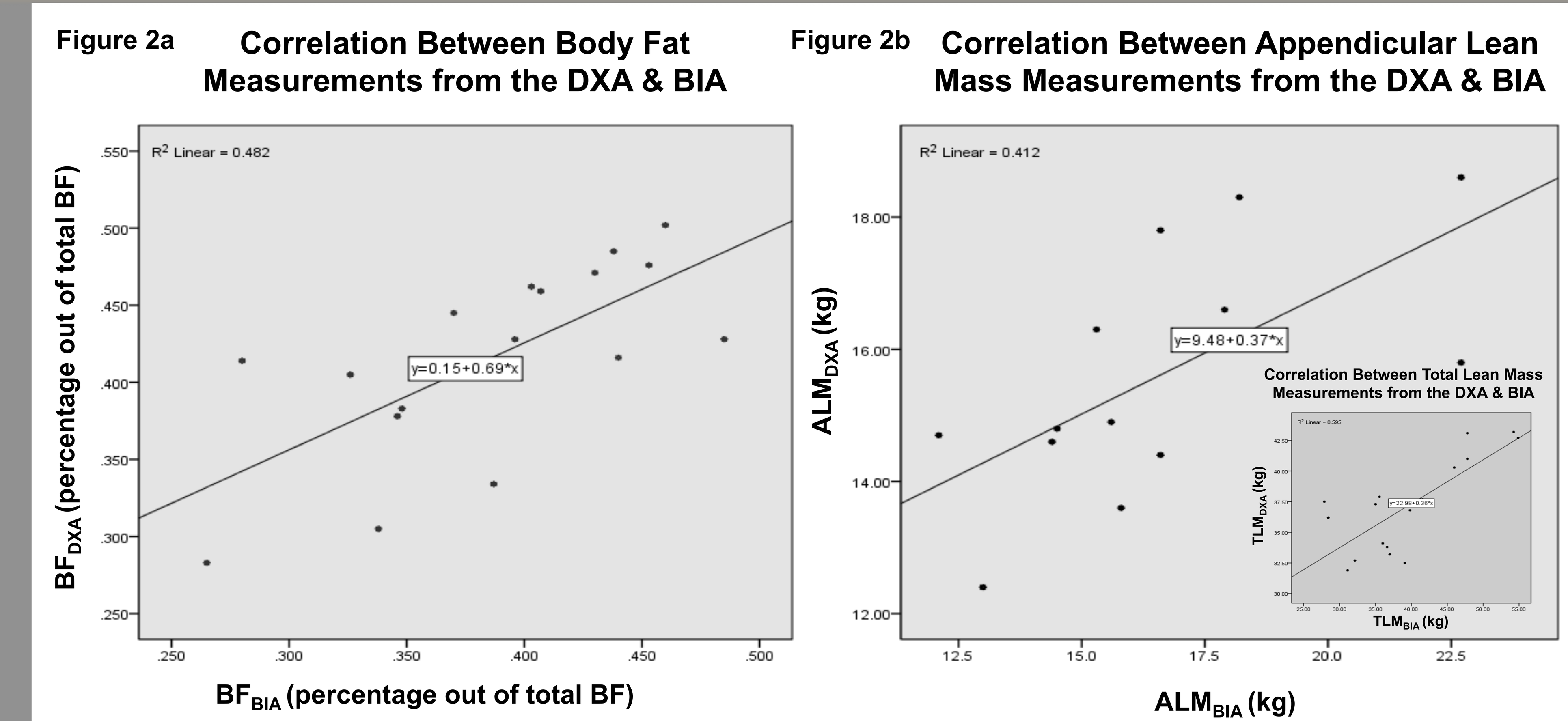

Figure 2a illustrates the weak correlation (r^2 = 0.482) between Body Fat measurements in percentage given by the DXA. **Figure 2b** illustrates the even weaker correlation (r^2 = 0.412) between Appendicular Lean Mass measurements in kg computed from the BIA output. The inset graph shows a higher, but still weak to moderate, correlation (r2 = 0.595) between Total Lean Mass measurements in kg given by the BIA.

Discussion & Future Directions

The proposed hypothesis stated there would not be a significant difference between the measurements taken with the DXA compared to those taken with the BIA. However, DXA measurements and those of the BIA showed weak to moderate correlations. Paired t test analysis of body fat (BF) measurements did show a significant difference between the means of the BF_{DXA} and BF_{BIA} measurements (p = 0.016). Conversely, paired *t* test analysis of lean mass, both appendicular lean mass (ALM) and total lean mass (TLM), showed no significant differences between means, supporting the hypothesis (p = 0.184 and p = 0.094 respectively). Unfortunately, these results are inconclusive due to very small sample sizes. Although the hypothesis was partially supported, future inquires should augment the sample sizes to ensure conclusive results.

Acknowledgements

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