In search of a practical tool to assess regional body composition

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Findings that regional accumulation or depletion of adipose tissue and fat signal an increased risk of chronic disease (1, 2) or are consequences of therapy (3) have prompted an advance in the use of methods to assess regional body composition in humans. This growing demand for accurate and sensitive methods of measurement poses unique challenges to the assumptions and physical bases of the available methods and to the need to develop diagnostic criteria that evaluate the impact of specific therapeutic regimens on the composition of these sites. In this issue of the Journal, Scherzer et al (4) describe the results of an observational study that examines the validity of magnetic resonance imaging (MRI) to estimate total-body dual-energy X-ray absorptiometry (DXA) compared with that of magnetic resonance imaging (MRI) to estimate total-body and regional fat mass in human immunovirus positive (HIV+) and healthy adults. This study is important because it addresses the practical issue of the use of a generally available and relatively low-cost method, DXA, as a surrogate for MRI—the established research tool used to measure regional adipose tissue volume and, by calculation, fat mass in clinical studies of human body composition. The principal finding is that DXA, regardless of manufacturer or type (pencil or fan X-ray beam), significantly overestimates total-body and regional fat mass, compared with MRI, in both HIV+ and control adults.

There is a paucity of studies that have compared measurements of regional fat depots determined with DXA and MRI. The few studies that have been conducted were limited by small sample sizes that included healthy adults; only one study reported a comparison of these methods in a limited number of HIV+ adults. Thus, the findings of the present study are a more robust comparison because they were derived from a multicenter trial with an appreciably greater number of HIV-negative and -positive adults than previously reported. Many of the potential problems associated with the use of multiple test locations have been controlled by using standardized measurement protocols and a single image reading center. Inclusion of a whole-body soft tissue phantom at the start of the study allowed a standardization of the individual DXA instruments. However, evidence of regular assessment of the accuracy and reliability of operation of each DXA scanner for the duration of the study is lacking.

Although DXA-derived fat mass was highly correlated with MRI determinations, the magnitude of the bias or error of DXA estimates increased directly in proportion to fat mass. Importantly, the overestimation of fat mass by DXA, when expressed as a percentage of the MRI-derived value, was greatest in the arms (up to 120%) compared with the legs (up to 70%) compared with the trunk (7%). This observation that DXA disproportionately overestimates limb fat depots in regions of the body in which amounts of fat are relatively low suggests that the basic assumption of DXA algorithms in sites such as the arms and legs may be inaccurate. Some explanations for the overestimation of fat by DXA include the interpolations for soft tissues located over bone (5) and the treatment of pixels containing a small portion of bone (6). Thus, the use of proprietary algorithms to calculate soft tissue composition hampers an understanding of the potential errors in DXA determinations of regional fat.

A novel approach to validation of DXA was the determination of the equivalence of DXA, relative to MRI, to assess the prevalence of a clinical outcome measure, peripheral lipatrophy, in HIV-infected and control adults. As expected, the HIV+ subjects had a lower distribution of leg fat than did control subjects measured by using MRI and DXA. The prevalence of lipatrophy by leg fat in the HIV-infected adults, operationally defined as the lowest decile of leg fat determined by DXA and MRI in control subjects, was significantly greater with DXA than with MRI in men (69% compared with 50%) and women (47% compared with 33%). This finding indicates that DXA is not a sensitive tool for use in diagnosing peripheral lipatrophy in HIV+ adults.

An explanation for the evident bias of DXA in estimating total-body and regional fat depots is not apparent. As argued by Scherzer et al, the expectation was that MRI might overestimate fat depots because of the inclusion of lipid and nonlipid components in the apparent fat volume determinations. Alternatively, the use of different types of DXA devices might have complicated this problem.

Although this study used different types of DXA devices (pencil and fan-beam systems) from different manufacturers, no comparisons of the total-body or regional soft tissues estimates were made.

1 From the US Department of Agriculture, ARS, Grand Forks Human Nutrition Research Center, Grand Forks, ND.
2 Mention of a trademark or proprietary product does not constitute a guarantee of the product by the United States Department of Agriculture and does not imply its approval to the exclusion of other products that may also be suitable.
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The lack of such a comparison confounds the interpretation of the findings because previous reports have shown significant differences in soft tissue composition by DXA manufacturer and type (7–9). Also, there is a lack of designation of the number of HIV+ and control subjects scanned by each DXA instrument. This information is fundamental in assessing whether the overestimation of fat mass is attributable to the predominant use of one or more DXA instruments that had been found previously to yield higher values for fat compared with reference methods or other DXA scanners.

This work by Scherzer et al highlights opportunities for needed research in human body-composition assessment. It emphasizes the importance of rigorously determining the accuracy and compatibility of regional (limb and trunk) soft tissue and bone estimates derived by various types of DXA instruments. These findings are needed to ensure the proper design of interventional, multicenter trials that include body-composition assessment as outcome measures. It also identifies another clinical use of body-composition assessment in the development of valid diagnostic criteria for assessment of risk of chronic disease and the effects of therapeutic interventions.

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REFERENCES