Comparison of methods for assessing body-composition changes over 1 y in postmenopausal women[1–3]

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ABSTRACT

Background: Advances in dual-energy X-ray absorptiometry (DXA) software algorithms have improved the accuracy of this method for body-composition measurement.

Objective: Our objective was to compare the utility of DXA, underwater weighing (UWW), and a multicomponent model (MC) for assessing changes in body composition.

Design: Previously sedentary women aged 40–66 y were randomly assigned to exercise training (ET; $n = 36$) and no exercise training (NT; $n = 40$). ET subjects exercised 3 d/wk; NT subjects remained sedentary. Changes in body mass, fat mass, and fat-free mass over 1 y were assessed by the 3 methods.

Results: Correlations among methods were significant and large (0.73–0.97). Body weight did not change significantly in either group. In the ET group, fat-free mass increased significantly as assessed by DXA (0.7 ± 1.0 kg) but changes assessed by MC and UWW were not significant. Changes in fat mass and percentage body fat in the ET group were not significant. SDs for changes in fat mass and percentage body fat, respectively, from DXA were 2.5 kg and 2.7%; for MC, 5.5 kg and 7.1%; and for UWW, 4.4 kg and 5.8%. In the NT group, changes in fat-free mass, fat mass, and percentage body fat were significant ($P \leq 0.02$) as assessed by MC (fat-free mass, -1.5 ± 3.7 kg; fat mass, 2.3 ± 4.1 kg; percentage body fat, $2.8 \pm 4.7\%$) and UWW (fat-free mass, -1.1 ± 2.5 kg; fat mass, 2.1 ± 3.6 kg; percentage body fat, $2.5 \pm 3.5\%$), but changes by DXA were not significant (fat-free mass, 0.2 ± 1.2 kg; fat mass, 1.0 ± 3.9 kg; percentage body fat, $0.6 \pm 3.2\%$).

Conclusion: DXA was the most sensitive method for assessing small changes in body composition of postmenopausal women. *Am J Clin Nutr* 2000;72:401–6.

INTRODUCTION

Accurate and precise assessment methods that are sensitive enough to track small changes in body compartments are essential for assessing the effects of intervention programs designed to alter body weight and composition. Various 2-component and multicomponent models have been used to estimate body composition. Two-component chemical models divide the body constituents into fat mass (FM) and fat-free mass (FFM) and use classic measurement techniques to estimate body composition, including the well-established techniques of hydrodensitometry and hydrometry (1, 2). Although these methods provide reasonably accurate results in weight-stable individuals whose FFM composition is similar to established reference values, they are not sufficiently precise to detect small changes in FM (<2–3%) and FFM (<2–2.5 kg), particularly if there are concomitant changes in FFM composition as well as in body fat (3).

To overcome the limitations of 2-component methods, multicomponent methods were developed that theoretically facilitate a more accurate estimation of body composition than 2-component approaches because more than one component is measured (4). Many multicomponent models have been developed in which measurements of total body water (TBW) and bone mineral content (BMC), the major components of FFM, rather than the assumed constants for these components are used for estimation of body composition (5). On the basis of these models, multicomponent prediction equations have been derived for use in the estimation of body composition in adults (6, 7).

Dual-energy X-ray absorptiometry (DXA) is a relatively new method for measuring body composition that provides measures of 3 chemical components of the body: FM, lean soft tissue mass (LTM), and total-body bone mineral (or BMC). FFM from DXA is the sum of LTM and BMC. DXA is a safe, convenient, and noninvasive method that involves only a small radiation dose (8, 9) and provides precise cross-sectional measurements of BMC and LTM (8, 10). However, Nelson et al (11) concluded that hydrodensitometry was a more sensitive method than DXA for detecting changes in body composition in older, weight-stable women.

Recent advances in software algorithms for body-composition assessment in general, and for trunkal fat in particular, underscore the rationale for investigating the utility of DXA

compared with other approaches for estimating body-composition changes (2, 12, 13). The purpose of this study was to compare a 2-component method and two 3-component methods to evaluate their sensitivity for measuring small changes in soft tissues over 1 y in 2 groups of women, one sedentary and the other participating in an exercise program. This 2-group design, exercise and no exercise, is a strategy for assessing face validity and interpretation of the utility of new methods for measuring change in body composition.

SUBJECTS AND METHODS

Subjects

The subjects were 76 healthy, sedentary, postmenopausal women participating in a study investigating the effects of progressive resistance and weight-bearing aerobic exercise training on bone mineral density (BMD). The study was approved by the University Human Subjects Institutional Review Board and all participants gave written, informed consent before participating in the study. The women were 3–10 y postmenopausal (40–66 y of age). At entry into the study, they had not participated in any regular exercise program, had a body mass index (BMI; in kg/m^2) above the 5th and below the 95th percentile of the National Center for Health Statistics standards (14), were currently nonsmokers, and had received hormone replacement therapy (HRT) for either >1 y (43%) or ≤1 y. Subjects did not take any other medications known to affect bone health and agreed to not change their body weights by using exercise or energy-reduction diets for 1 y. All subjects agreed to take calcium supplements that provided 800 mg elemental Ca/d.

Study design and intervention protocol

The study design was a partially randomized, 1-y clinical trial. Women who were sedentary and had previously chosen to receive HRT or to not receive HRT were randomly assigned to a supervised exercise-training group (ET group; $n = 36$) or a no-exercise group (NT group; $n = 40$) after completing the screening phase of the study. Screening consisted of a physical examination, posture assessment, medical and physical activity histories, DXA scans, blood pressure measurement, and a graded treadmill exercise test. The ET group participated in rigorous, progressive, high-intensity resistance exercise training and weight-bearing aerobic exercise 3 d/wk for 1 y and the NT group continued their usual sedentary activities.

The ET group performed 8 different resistance exercises using free weights and weight machines. The load for the training stimulus was set at 70–80% of the most recently determined 1-repetition maximum (1-RM) for the latissimus dorsi pull-down, leg press, overhead press, back extension, and seated row exercises. The 1-RM testing to assess strength changes was conducted every 8 wk. Training intensity levels for the rotary torso, weighted marching, and squats were determined by ratings of perceived exertion. The load was adjusted for each exercise as tolerated at training sessions to maintain progressive increases in the load. The first set included 6–8 repetitions for each exercise and the second set included 6–10 repetitions in proper form. The weight-bearing aerobic exercises included a warm-up, 25 min of stair climbing, and combinations of jogging, skipping, hopping, jumping, sidestepping, or walking with a weighted vest. Exercises for strengthening abdominal muscles

and small muscles around the spine, for balance, and stretching were included in the cool down. One of the 3 weekly exercise sessions was performed at the higher end of the range of intensity (80% 1-RM; stair stepping was completed without a weighted vest on this day) and 2 sessions at moderate intensity (70–75% 1-RM; wearing a weighted vest).

Body-composition measurements

All body-composition measurements were made at baseline and 1 y later.

Anthropometry

Standing height was measured in subjects without shoes or socks and after a maximal inhalation to the nearest 0.1 cm by using a wall-mounted stadiometer. Body weight (kg) of subjects clad in a light-weight swimsuit was measured on a calibrated digital scale (model 770; SECA Corp, Hamburg, Germany) accurate to 0.1 kg. The average of 2 measurements for both height and weight was used as the criterion measurements.

Dual-energy X-ray absorptiometry

DXA measurements were made with a total body scanner (model DPX-L; Lunar Radiation Corp, Madison, WI) that uses a constant potential X-ray source of 78 kVp and a rare-earth K-edge filter to achieve a congruent beam of stable dual-energy radiation with effective energies of 40 and 70 keV. The scanner was calibrated daily against the standard calibration block supplied by the manufacturer. In addition, a spine phantom was scanned daily throughout the study period and the CV for the BMD of the spine phantom was 0.6%. Each subject was scanned twice within a 2-wk period and the mean of the 2 measurements was used in all analyses. Subject position and scan procedures were similar to those described by Going et al (3). A series of transverse scans was made from head to toe at 1-cm intervals at a scan speed of 8 cm/s.

All scans were analyzed by one technician. Total-body BMC, FM, and bone-free LTM were derived according to the computer algorithms (software version 1.3 y, extended research analysis mode) provided by the manufacturer (Lunar Radiation Corp). FFM from DXA was calculated as the sum of total-body BMC and LTM. Hence, FFM from DXA included all LTM and bone mineral mass but not FM.

Hydrodensitometry

Body density was estimated from underwater weight by following the procedures of Akers and Buskirk (15) with a correction for residual lung volume by using the oxygen dilution method described by Wilmore (16). Residual lung volume was estimated simultaneously with underwater weight while the subject was submerged in water (1). Body fat as a percentage of body weight (%Fat) was calculated from the Siri 2-component model equation (17) as follows:

$$\%\text{Fat} = [4.95/\text{body density} - 4.50] \times 100 \qquad (1)$$

Multicomponent model

%Fat was also estimated by using a multicomponent model that includes body density and total mineral mass as a fraction of body mass (7) as follows:

$$\%\text{Fat} = [6.386/\text{body density} + 3.961(\text{M}) - 6.090] \times 100 \qquad (2)$$

where M is total mineral mass as a fraction of body mass.

TABLE 1
Summary of the study of body-composition assessment techniques, models, equations, technical errors, and reliability[1]

Measurement technique	Model and equation	Technical error	CV
			%
Multicomponent	%Fat = [(6.386/D_b) + (3.961 × TMM/BM) − 6.09] × 100	1.331	3.5
Dual-energy X-ray absorptiometry			
Total-body lean soft tissue mass	LTM (g); attenuation energy = 1.4	0.086	2.2
Total-body fat mass	FM (g); attenuation energy = 1.2	0.091	3.4
Total-body mineral mass	TMM (g) = BMC (g) × 1.279	36.8	1.6
Hydrostatic weighing	D_b = BM (kg)/body volume (L)	0.003	0.3
	%Fat = (495/D_b − 450)	1.45	3.7
	FM (kg) = BM × %Fat/100	0.99	3.7
	FFM (kg) = BM − FM	0.99	2.4

[1] Technical error indicates precision measurement; CV refers to specific results of repeated-measurement testing described in the text; %Fat, percentage of body weight; D_b, body density; TMM, total-body mineral mass [precision is calculated for bone mineral content (BMC)]; BM, body mass; LTM, lean tissue mass; FM, fat mass.

Total-body mineral mass (TMM) was estimated from DXA osseous mineral by adjusting the ratio of osseous to nonosseous mineral and the loss of mineral during the ashing of bone (18) as follows:

$$TMM\ (g) = BMC × 1.279 \tag{3}$$

Once %Fat was estimated from Equations *2* and *3*, FFM and FM were calculated by using the following equations:

$$Body\ weight\ (kg) × \%Fat = FM\ (kg) \tag{4}$$

$$Body\ weight\ (kg) − FM\ (kg) = FFM\ (kg) \tag{5}$$

Technical error of measurement

The models, equations, technical errors, and CVs are summarized in **Table 1**. The technical errors for assessment of total body LTM, FM, and BMC by DXA were estimated from repeat scans (2 scans within 2 wk; *n* = 88). Technical errors for measurements of body density, FM, FFM, and %Fat by UWW were calculated from the residual mean square resulting from a one-way, repeated-measures analysis of variance (trials; *n* = 142). For the MC model the overall technical error was estimated from the technical error for body density and BMC.

Statistical analyses

Descriptive statistics including means ± SDs were calculated for all primary outcome measures. Baseline comparisons of mean values for age, height, body weight, and BMI between the ET and NT groups were made by using independent *t* tests. Correlations among the 3 methods for estimation of FM, FFM, and %Fat were assessed by using zero-order correlation coefficients. Regression analysis was used to assess the relations between changes in body-composition variables over 1 y within each group for each of the 3 body-composition-assessment methods. Results were considered statistically significant if *P* was ≤ 0.05. SPSS (19) was used for all analyses.

RESULTS

Baseline characteristics

The means and SDs for the baseline descriptive characteristics of the subjects in the ET and NT groups are summarized in

Table 2. There were no significant differences at baseline between the ET and NT groups in age, height, body weight, or BMI.

Strength changes

The average changes for 1-RM values between baseline and 1 y for the ET group for latissimus dorsi pull-down, leg press, overhead press for right and left arms, back extension, and seated row exercises were, respectively, 38%, 114%, 38% and 43%, 46%, and 22%.

Correlations among methods

The correlations among DXA, UWW, and multicomponent estimates of FM, FFM, and %Fat at baseline and at 1 y were large and significant (**Table 3**). The SEEs were good to excellent (4). Correlations of changes in FFM, FM, and %Fat over 1 y measured by DXA, the multicomponent model, and UWW were significant, except for the correlation between DXA and the multicomponent model for FFM. Correlations among methods were moderate to low, depending on the outcome variable (**Table 4**). Correlations at baseline were higher for FM (DXA and UWW: *r* = 0.94, DXA and multicomponent: *r* = 0.89) than for %Fat (DXA and UWW: *r* = 0.81, DXA and multicomponent: *r* = 0.73) because the SD relative to the average FM value is always higher than the SD for %Fat because %Fat adjusts for body size.

Regression analyses

The means and SDs for the baseline values and changes over 1 y in body weight, FFM, FM, and %Fat for the 3 methods are summarized in **Table 5**. The small comparable increases in body weight measured with a scale and by DXA were not significant for either the ET or the NT group. The SDs for the body weight changes were larger for the NT group than for the ET group.

TABLE 2
Baseline characteristics of study participants in the exercise training and no exercise training groups[1]

Variable	Exercise training (*n* = 36)	No exercise training (*n* = 40)
Age (y)	56.1 ± 4.2	55.3 ± 5.7
Height (cm)	162.6 ± 7.8	161.5 ± 5.2
Weight (kg)	69.5 ± 11.5	67.1 ± 10.3
BMI (kg/m²)	26.1 ± 3.6	25.7 ± 3.8

[1] $\bar{x}$ ± SD. There were no significant differences between groups.

TABLE 3
Correlations of body-composition variables estimated by DXA, UWW, and multicomponent methods at baseline and 1 y[1]

	UWW model		Multicomponent model	
	Baseline	1 y	Baseline	1 y
FFM by DXA (kg)	0.87 (2.4)	0.92 (1.9)	0.80 (2.8)	0.91 (2.1)
FM by DXA (kg)	0.94 (2.7)	0.97 (2.0)	0.89 (3.5)	0.96 (2.3)
%Fat by DXA	0.81 (3.5)	0.91 (3.0)	0.73 (4.2)	0.88 (3.4)

[1] r; SEE in parentheses; $n = 76$. All r values significant at $P \leq 0.05$. DXA, dual-energy X-ray absorptiometry; UWW, underwater weighing; FM, fat mass; FFM, fat-free mass; %Fat (Siri) = (495/body density − 450).

For FFM in the ET group, there was a small, significant increase when assessed by DXA and very small, nonsignificant decreases when assessed by the multicomponent prediction equation and UWW when using the Siri 2-component equation. There were no significant changes in FM and %Fat in the ET group when assessed by any of the 3 methods.

In the NT group, the changes in FFM, FM, and %Fat were significant when assessed by the multicomponent model and by UWW. The magnitudes of the decreases in FFM were not significantly different for the multicomponent model and for UWW. In addition, the sizes of the increases in FM and %Fat estimated by using the multicomponent equation and UWW were also not significantly different. The small increases in FFM, FM, and %Fat assessed by DXA were not significant. The SDs for the changes in these body-composition variables were the smallest for DXA estimates in both the ET and NT groups.

DISCUSSION

A unique aspect of this study was the examination of the face validity of body-composition assessment methods for measuring small changes in composition over 1 y by including 2 groups of postmenopausal women, one sedentary and the other in a supervised exercise program. In the ET group over 1 y, there were large increases in strength assessed by changes in 1-RM values. The results of our study for DXA estimates of body composition show the changes that were anticipated. It was expected that, on average, the ET group would have a small increase in FFM and small decreases in FM and %Fat, whereas the NT group would have minimal changes in FFM and small increases in FM and %Fat.

We found high correlations and low SEEs between the DXA, UWW, and multicomponent methods for cross-sectional estimates of FFM, FM, and %Fat at baseline and 1 y in our sample of women. Other studies also showed that DXA estimates of body composition correlate well with estimates from UWW in healthy subjects (20–22). In a comparison of estimates of %Fat between UWW and dual-photon absorptiometry in a sample of subjects aged 19–94 y, Wang et al (23) reported that the differences in %Fat estimates among methods varied widely and that the differences were positively correlated with the density of lean body mass, and, in particular, with the ratio of the total-body BMC to lean body mass. Hansen et al (24) reported that DXA was a precise method for estimating %Fat and that these estimates correlated highly with %Fat and FFM estimates from UWW, with little improvement when body density was corrected for variation in BMD in a cross-sectional sample of women aged 28–39 y.

In our study, the correlations of the changes in body composition over 1 y were significant among the 3 methods. Thus,

in this sample of women, BMD did not account for significant variation in changes in density of the FFM. The average estimates of FFM, FM, and %Fat were also similar between the UWW and multicomponent methods. Therefore, our main focus was on comparing DXA with UWW, rather than with the multicomponent method.

Two earlier reviews raised concerns about the accuracy of DXA as a criterion method (25, 26) that were subsequently addressed by Pietrobelli et al (27) and Kohrt (2). Pietrobelli et al (27) calculated the theoretic effect of changing hydration on DXA estimates of body composition and found only a small bias associated with the largest changes in TBW, with less than a 1% change in %Fat for every 5% change in TBW. There is no reason to expect systematic changes in TBW as a fraction of FFM with the magnitude of changes in FFM found in this study. Kohrt (2) showed that the Hologic QDR-1000/W instrument with version 5.64 of the enhanced whole-body analysis program improved the accuracy of estimates of %Fat made using DXA in a sample with an age range of 21–81 y (28).

However, when the data were examined separately for men and women in the study by Kohrt (2), there was a discrepancy between the methods that was significantly and inversely related to the ratio of BMC to FFM. Correction of the density of FFM for individual variance in BMC:FFM reduced the difference in estimates of FM between the methods in men but unexpectedly widened the difference between methods in women. However, when the density of FFM was corrected for individual variance in BMC:FFM and for sex-specific estimates of TBW:FFM and protein:FFM based on the work of Modlesky et al (29), then the

TABLE 4
Correlations of changes over 1 y in body-composition variables estimated by DXA and multicomponent or UWW methods[1]

Body-composition variable and method	Exercise training ($n = 36$)	No exercise training ($n = 40$)
FFM		
DXA versus multicomponent model	0.25	0.26
DXA versus UWW	0.33[2]	0.31[2]
FM		
DXA versus multicomponent model	0.61[2]	0.64[2]
DXA versus UWW	0.68[2]	0.76[2]
%Fat		
DXA versus multicomponent model	0.48[2]	0.33[2]
DXA versus UWW	0.54[2]	0.46[2]

[1] DXA, dual-energy X-ray absorptiometry; UWW, underwater weighing; FFM, fat-free mass; FM, fat mass; %Fat (Siri) = (495/body density − 450).
[2] $P \leq 0.05$ (two-tailed t test).

TABLE 5
Comparisons of body-composition changes between baseline and 1 y by measurement technique with exercise training and no exercise training[1]

	Exercise training (n = 36)				No exercise training (n = 40)			
	Baseline	1 y	Change[2]	P (for change)	Baseline	1 y	Change[2]	P (for change)
Weight (kg)								
Scale	69.5 ± 11.5	69.6 ± 11.2	0.1 ± 2.5	0.833	67.1 ± 10.3	67.9 ± 11.4	0.8 ± 4.3	0.247
DXA	68.7 ± 11.2	68.8 ± 11.2	0.1 ± 2.3	0.714	65.8 ± 10.1	67.0 ± 11.4	1.2 ± 4.4	0.090
FFM (kg)								
MC	42.5 ± 6.2	42.4 ± 5.7	−0.1 ± 4.2	0.882	41.8 ± 5.9	40.3 ± 5.1	−1.5 ± 3.7[3]	0.016
DXA	41.7 ± 5.2	42.4 ± 5.1	0.7 ± 1.0[3]	0.001	40.3 ± 4.2	40.5 ± 4.4	0.2 ± 1.2	0.462
UWW	42.4 ± 5.9	42.2 ± 5.4	−0.2 ± 3.4	0.653	41.5 ± 5.2	40.4 ± 5.0	−1.1 ± 2.5[3]	0.009
FM (kg)								
MC	26.6 ± 7.8	27.2 ± 7.8	0.6 ± 5.5	0.490	25.3 ± 7.2	27.6 ± 8.1	2.3 ± 4.1[3]	0.001
DXA	27.0 ± 8.0	26.5 ± 8.5	−0.5 ± 2.5	0.252	25.5 ± 7.3	26.5 ± 8.9	1.0 ± 3.9	0.092
UWW	27.1 ± 7.9	27.5 ± 7.9	0.4 ± 4.4	0.623	25.4 ± 7.0	27.5 ± 8.2	2.1 ± 3.6[3]	0.001
%Fat								
MC	38.0 ± 7.6	38.5 ± 6.4	0.5 ± 7.1	0.621	37.2 ± 6.7	40.0 ± 6.3	2.8 ± 4.7[3]	0.001
DXA	38.6 ± 6.4	37.7 ± 7.2	−0.9 ± 2.7	0.061	38.1 ± 5.8	38.7 ± 7.1	0.6 ± 3.2	0.205
UWW	38.5 ± 7.1	38.9 ± 6.3	0.4 ± 5.8	0.663	37.3 ± 6.1	39.8 ± 6.4	2.5 ± 3.5[3]	0.000

[1] $\bar{x}$ ± SD. DXA, dual-energy X-ray absorptiometry; FFM, fat-free mass; MC, multicomponent model; UWW, underwater weighing; FM, fat mass; %Fat (Siri) = (495/body density − 450).

[2] Value at 1 y − baseline.

[3] Measurements at baseline and 1 y were significantly different, $P \leq 0.05$.

age- or sex-related differences in the estimates of %Fat were eliminated. Kohrt (2) concluded that these results in a cross-sectional sample suggest that DXA is superior to UWW for the assessment of body composition and recommended that additional studies be done to confirm her findings.

Early work using Lunar instruments showed that the high precision of dual-photon absorptiometry for estimation of body-composition components provided the technology to detect previously unrecognizable small changes in body composition (30). Studies in hemodialysis patients and healthy adults have shown that DXA accurately assessed acute changes in soft tissue (31, 32). DXA also appears to be a suitable method for assessing body-composition changes in longitudinal studies (33).

Results from DXA measurements in our study over 1 y indicated a small, significant increase in FFM in the ET group and a very small nonsignificant increase in FFM in the control group. A similar study by Nichols et al (34) using an earlier version of Lunar software (version 3.4) showed a significant increase in FFM measured by DXA after 1 y of resistance training in a group of women aged 60–80 y, but the study did not include a control group.

In contrast, a study by Nelson et al (11) compared the ability of several body-composition assessment techniques to detect changes in soft tissue in 2 groups of older women: a strength-training group and a control group. These investigators concluded that compared with DXA, UWW was the more sensitive measure of increased FFM in the strength-training group. This conclusion was based on their results showing that DXA (Lunar DPX with version 3.4 software), anthropometry, bioelectrical impedance, and total body nitrogen and carbon analyses did not measure any significant change in soft tissue but that UWW showed a significant decrease in FM in the strength-training group compared with the control group. The nonsignificant increase in FFM estimated by DXA in the strength-training group was 0.6 kg or 1.6% and the FFM change in the control group was 1.4 kg or 4%, but SDs of these change measurements were not reported.

Results from UWW in our study showed nonsignificant increases in FM and %Fat for the ET group and significant increases in the NT groups. FM estimates from UWW, reported by Nelson et al (11), showed a decrease of 0.8 ± 1.7 kg for the strength-training group compared with an increase of 0.4 ± 2.2 kg for the control group (P = 0.03). Our results from UWW assessments for FFM showed a nonsignificant decrease in the ET group and a significant decrease in the NT group. In contrast, results from UWW measurements reported by Nelson et al (11) showed a significant 1.3 ± 0.7-kg increase in FFM in the strength-training group and an increase of 0.2 ± 0.9 kg in the control group.

In our study, the SDs for the changes in the body-composition variables were the smallest for DXA estimates in the ET and NT groups. Consequently, the estimates of FFM, FM, and %Fat from DXA had the smallest variability and, therefore, when compared with results from UWW and multicomponent, were the most sensitive measures for detecting small changes in body composition in this sample of women.

The sensitivity of the methods used in the study by Nelson et al (11) cannot be evaluated because the SDs of the changes in the DXA estimates of FFM and FM were not reported. In addition, the body weight from the sum of FFM and FM estimated by DXA was also not reported. To advance our understanding of the sensitivity of DXA for tracking changes in body composition, investigators need to report not only the difference in the change in body-composition variables but also the SDs of the differences and the sum of FFM and FM estimates from DXA compared with body weight measured with a scale.

The results of our study indicate that compared with UWW and a multicomponent model that adjusts for variance in the mineral fraction of FFM, DXA measurements, analyzed with current versions of software programs, provide a more sensitive method for assessing small changes in body composition in postmenopausal women. The DXA measurements showed a significant increase in FFM in the ET group but no significant changes in body weight, FM, or %Fat and no significant changes in any body-composition variable for the NT group.

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