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One- and two-year change in body composition as measured by DXA in a population-based cohort of older men and women

Marjolein Visser,[1,2] Marco Pahor,[3] Frances Tylavsky,[4] Stephen B. Kritchevsky,[4] Jane A. Cauley,[5] Anne B. Newman,[6] Barbara A. Blunt,[7] and Tamara B. Harris[2]
[1]*Institute for Research in Extramural Medicine, Vrije University Medical Center, 1081 BT Amsterdam, The Netherlands;* [2]*Laboratory of Epidemiology, Demography and Biometry, National Institute on Aging, Bethesda, Maryland 20892;* [3]*Sticht Center on Aging, Department of Internal Medicine, Wake Forest University School of Medicine, Winston-Salem, North Carolina 27157;* [4]*Department of Preventive Medicine, University of Tennessee, Memphis, Tennessee 38105; Departments of* [5]*Epidemiology and* [6]*Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania 15261; and* [7]*Department of Epidemiology and Biostatistics, University of California, San Francisco, California 94105*

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Visser, Marjolein, Marco Pahor, Frances Tylavsky, Stephen B. Kritchevsky, Jane A. Cauley, Anne B. Newman, Barbara A. Blunt, and Tamara B. Harris. One- and two-year change in body composition as measured by DXA in a population-based cohort of older men and women. *J Appl Physiol* 94: 2368–2374, 2003. First published February 21, 2003; 10.1152/japplphysiol.00124.2002.—Changing body composition has been suggested as a pathway to explain age-related functional decline. No data are available on the expected changes in body composition as measured by dual-energy X-ray absorptiometry (DXA) in a population-based cohort of older persons. Body composition data at baseline, 1-yr follow-up, and 2-yr follow-up was measured by DXA in 2,040 well-functioning black and white men and women aged 70–79 yr, participants of the Health, Aging, and Body Composition Study. After 2 yr, a small decline in total body mass was observed (men: −0.3%, women: −0.4%). Among men, fat-free mass and appendicular lean soft tissue mass (ALST) decreased by −1.1 and −0.8%, respectively, which was masked by a simultaneous increase in total fat mass (+2.0%). Among women, a decline in fat-free mass was observed after 2 yr only (−0.6%) with no change in ALST and body fat mass. After 2 yr, the decline in ALST was greater in blacks than whites. Change in total body mass was associated with change in ALST (r = +0.58 to +0.70; $P <$ 0.0001). Among participants who lost total body mass, men lost relatively more ALST than women, and blacks lost relatively more ALST than whites. In conclusion, the mean change in body composition after a 1- to 2-yr follow-up was 1–2% with a high interindividual variability. Loss of ALST was greater in men compared with women, and greater in blacks compared with whites, suggesting that men and blacks may be more prone to muscle loss.

lean soft tissue; longitudinal study; sarcopenia; race; gender; dual-energy X-ray absorptiometry

CHANGES IN BODY COMPOSITION with aging may have important consequences on health and physical functioning in old age and is an area of increasing interest in aging research. It has been hypothesized that the loss of skeletal muscle mass with aging, or sarcopenia, may increase the risk for disability (20). In addition, interventions are being developed to favorably influence body composition in old age. For example, exercise and pharmaceutical interventions have been carried out to increase muscle mass and exercise and diet interventions to decrease total body fat (8, 12, 13, 17, 23).

Dual-energy X-ray absorptiometry (DXA) is increasingly used to assess body composition in older persons. The method has been validated against multislice computed tomography scans, magnetic resonance imaging, and a four-compartment body composition model in young and older persons (6, 22, 26, 27). The method has a good reported reproducibility [coefficient of variation for total body fat mass 2–3%, total body fat-free mass and total body lean soft tissue 1–2%, arm lean soft tissue 3–4%, leg lean soft tissue 1–2% (3, 4, 6)], is a sensitive method for assessing small changes in body composition (12), and requires little subject effort. Moreover, in contrast to many other body composition methods, DXA has the potential to assess the composition of the total body as well as body regions.

Because of these characteristics, DXA has been used to determine both long-term change in body composition with aging (9) and short-term change in body composition as a result of intervention (8, 12, 13, 17, 23). However, little is known about the short-term change in body composition in older persons as measured by DXA and the variability of this change. This knowledge is essential for the development of intervention trials with sufficient statistical power to detect differences in body composition between intervention and control groups. In addition, whereas gender and race differences in body composition have been documented cross-sectionally (1, 10), it is unknown whether differences would be observed prospectively with aging. Furthermore, the association between changes in

Address for correspondence: M. Visser, Institute for Research in Extramural Medicine, Vrije University Medical Center, Van der Boechorststraat 7, 1081 BT Amsterdam, The Netherlands.

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body weight and body composition in older persons has received little attention.

This study was conducted to address three research questions. First, what are the 1- and 2-yr changes in body composition as measured by DXA in a large population-based cohort of black and white men and women aged 70–79 yr? Second, are the observed body composition changes different between gender and race groups? And last, what is the relationship between body weight change and change in body composition in older persons?

METHODS

Study population. The Health, Aging, and Body Composition (Health ABC) Study cohort includes 3,075 black and white men and women. Whites were recruited from a random sample of Medicare beneficiaries residing in zip codes from the metropolitan areas surrounding Pittsburgh, PA and Memphis, TN. Blacks were recruited from all age-eligible residents in these geographic areas. After receiving information describing the study, potential participants were screened for eligibility. Eligibility criteria included the following: age 70–79 yr in the recruitment period from March 1997 to July 1998; self-report of no difficulty walking one-quarter of a mile or climbing 10 steps without resting; no difficulty performing basic activities of daily living; no reported use of a cane, walker, crutches, or other special equipment to get around; no history of active treatment for cancer in the prior 3 yr; and no plan to move out of the area in the next 3 years.

Of the 3,075 participants at baseline, 77 died and 22 were unable to be contacted, withdrew from the study, or moved out of the area after 2 yr. A total of 725 participants had incomplete body composition data at baseline, 1-yr follow-up or two-year follow-up and were excluded from the statistical analyses to allow comparison of 1- and 2-yr change in body composition in the same group of participants. Furthermore, because body composition changes are likely to be dependent on the duration of follow-up, our analyses were restricted to those participants who had their 1-yr follow-up visit after 1 yr ± 3 mo and their 2-yr follow-up visit after 2 yr ± 3 mo. Complete data on 2,040 participants (684 white men, 330 black men, 598 white women, 428 black women) were available for the analyses (66.3% of original cohort).

Compared with the 2,040 participants included in the analyses, those who were excluded or were lost to follow-up had a similar amount of appendicular lean soft tissue mass (20.5 vs. 20.5 kg) and total body fat-free mass (49.8 vs. 49.7 kg), had a greater total body fat mass (26.6 vs. 25.6; $P = 0.002$) at baseline, were more likely to be female (female: 53.9 vs. 50.3%; $P = 0.06$) and were more likely to be black (50.5 vs. 37.2%; $P = 0.001$).

Body composition. Total body mass and body composition at baseline, 1-yr follow-up, and 2-yr follow-up were measured with DXA using fan beam DXA (Hologic QDR4500A, software version 8.21). Appendicular lean soft tissue mass, calculated as the sum of lean soft tissue (nonfat, nonbone) mass in the arms and legs, was used as an indicator of skeletal muscle mass. Total body fat-free mass, which includes both lean soft tissue and bone mineral, and trunk lean soft tissue were also assessed. The fat measures included total body fat mass, trunk fat mass, and appendicular fat mass. We included these different measures of the lean and fat body component because they all have been used as study outcomes in intervention studies. Absolute change in each body composition measure was calculated as follow-up value minus baseline value.

The Health ABC Study strived to ensure good long-term precision (reproducibility) by utilizing a detailed DXA operations manual, providing annual DXA operator training, and contracting the services of an experienced DXA reading center. A whole body phantom and human volunteers were used throughout the study for quality control of the DXA scanners. We used the Hologic Whole Body Phantom as described in the Hologic document no. 080-0857 revision A, dated September 2000, available from Hologic Customer Service at 1-800-321-4659. Each scanner had its own whole body phantom, which was scanned three times per week throughout the course of the study. We determined the "break point date" where the mean of the phantom bone mineral density (BMD) or bone mineral content (BMC) data made an abrupt "step" change by *1*) reviewing the longitudinal plot of the phantom data, *2*) determining that major repairs were made at that time, and *3*) running the phantom data through a statistical cumulative sum program to determine the exact date of the break point (16). The correction was calculated as the percent change of the mean between the two intervals on either side of the breakpoint. Scans performed after the break point date were multiplied by a correction factor to make the BMD and BMC equivalent to what we estimate they would have been had the scanner functioned in a stable manner. All corrections are made to individual data. Specifically, the Memphis whole body BMD and BMC values were adjusted for a 2.3% shift in BMD that occurred during the first round of follow-up scanning, and Pittsburgh whole body BMC and area values were adjusted for a 1.7% shift in BMC that occurred during the second round of follow-up scanning.

Additionally, the Pittsburgh DXA scanner overestimated total mass by ~2%, which was determined by comparison with the scale weight of each subject. From independent data, the calibration of the scale was known to be correct and was taken as truth. The fat, lean, lean minus BMC, and total mass were adjusted proportionately. The BMC was not adjusted because the calibration of BMC and total mass are independent in the scanner software. The adjustments were made to individual data and were made for the total body and all the subregions.

Whole body artifacts were recorded and classified for location, type of tissue affected, and severity. A complex algorithm was used to adjust the total and subregion whole body values for the presence of artifacts. If the region of interest was changed during follow-up because of incident changes or inability to position the participant exactly the same as at preceding scans, the preceding scans were reanalyzed by using the new region of interest to allow calculation of meaningful change variables.

It was determined by an independent study (2, 24, 25) that the QDR4500A scanners overestimate fat-free mass compared with the four-compartmental model criterion method. Corrections were accomplished by multiplying the "lean with BMC" by 0.964 and leaving the total mass unchanged. From those two variables, the fat, lean minus BMC, and percent fat were recalculated. The adjustments were made to individual data for the total body and all the subregions.

Potential confounders. Potential confounders that could explain potential gender or race differences in change in body composition included age, study site, physical activity, smoking status, oral estrogen use (women only), and health status. Physical activity of the past 7 days was assessed by an interviewer-administered questionnaire. The total time spent on walking for exercise and walking for other purposes was categorized as never, <150 min/wk, and >150 min/wk.

Smoking status was based on self-report and categorized as never, former and current smoker. Oral estrogen use was determined from drug data coded using the Iowa Drug Information System ingredient codes. Current presence of disease was determined using self-reported physician-diagnosed disease information, clinic data and medication use. The total number of diseases was used as an indicator of health status. The diseases included were cerebrovascular disease (self-reported history of stroke, transient ischemic attack, or carotid endarterectomy), coronary heart disease (self-reported history of coronary artery bypass graft or percutaneous transarterial coronary angioplasty or coronary heart disease), peripheral arterial disease (self-reported history of claudication or history of lower extremity bypass or angioplasty), congestive heart failure (self-reported history of congestive heart failure), current symptomatic hip or knee osteoarthritis (self-reported history of knee or hip osteoarthritis and a history of knee or hip symptoms in the past year), osteoporosis (self-reported history of osteoporosis or use of osteoporosis medication), pulmonary disease (self-reported history of current asthma, chronic bronchitis, emphysema, or chronic obstructive pulmonary disease and medication use), diabetes mellitus (self-reported diagnosis of diabetes and medication use or a fasting glucose concentration ≥126 mmol/l), and depression (use of antidepressants).

Statistical analyses. Analyses were performed stratified by gender and race with SAS software (SAS Institute, Cary, NC). The lean soft tissue measures, body fat measures, total fat-free body mass, and total body mass were used as continuous variables in the study. In addition, a categorical variable was created for relative change in appendicular lean soft tissue by using a cutoff point of 3%. This cutoff point was based on the reported coefficient of variation for DXA soft tissue (3, 4, 7), and a change >3% was unlikely to represent only measurement error. For consistency, the change in total body mass was categorized by using the same cutoff value. Reported correlations were Pearson's product-moment correlations. Changes in body composition over time were tested by using paired *t*-tests. Potential gender differences or racial differences in the change in body composition were tested by using Student's *t*-tests. Because the analyses include multiple comparisons, the results of the statistical tests are presented at the $P < 0.05$ and the $P < 0.01$ level. Analysis of covariance was used to test potential gender or race differences in the change in appendicular lean soft tissue mass after 2 yr of follow-up, adjusting for potential confounders, including age, study site, physical activity, smoking status, oral estrogen use (women only), and health status.

RESULTS

Several baseline characteristics of the study participants are shown in Table 1. Blacks were more likely to be current smokers and were less likely to use oral estrogens (women only). Blacks were less active and were generally more likely to have prevalent chronic disease. The prevalence of depression and osteoporosis was lower in blacks than whites.

Body composition at baseline of the study is shown in Table 2. Blacks had more lean soft tissue in the trunk and extremities and more total body fat-free mass compared with whites. Even though total body mass was similar between black and white men, black men had less total body fat mass compared with white men. Black women were heavier and had a greater total body fat mass compared with white women.

A small decline (−0.3 to −0.4%) in total body mass was observed after 2 yr of follow-up (Table 3). The change in total body mass was not different between men and women. Men experienced a decline in lean soft tissue mass, both in the extremities and the trunk, and a decline in total body fat-free mass after 1 yr. This change was even more pronounced ($P < 0.01$) after 2 yr of follow-up. A greater decline in lean soft tissue was observed for the legs compared with the arms. In contrast to the lean tissues an increase in total body fat

Table 1. *Baseline characteristics (1997/1998) of participants of the Health, Aging, and Body Composition Study*

	Men			Women		
	White (n = 684)	Black (n = 330)	All (n = 1,014)	White (n = 598)	Black (n = 428)	All (n = 1,026)
Age, yr	73.8 ± 2.9	73.5 ± 2.7	73.7 ± 2.8	73.5 ± 2.8	73.2 ± 2.9	73.4 ± 2.8
Smoking status, %						
Never	30.5	31.5	30.8	59.7	58.3	59.1
Former	65.0	48.8	59.7	34.0	30.7	32.6
Current	4.5	19.7†	9.5	6.3	11.0*	8.3
Walking activity, %						
0 min/wk	31.4	46.5	36.4	37.6	49.5	42.6
<150 min/wk	31.8	29.5	31.0	33.2	30.5	32.1
>150 min/wk	36.8	24.0†	32.6	29.2	20.0†	25.3
Oral estrogen use, %				32.3	13.3†	24.4
Prevalent disease, %						
Cerebrovascular disease	6.6	9.7	7.6	7.5	8.2	7.8
Coronary heart disease	26.9	22.1	25.4	11.9	16.4*	13.7
Peripheral arterial disease	5.4	5.8	5.5	2.3	5.6†	3.7
Congestive heart failure	2.9	3.3	3.1	1.0	2.8*	1.8
Symptomatic osteoarthritis	3.4	2.4	3.1	8.0	7.2	7.7
Pulmonary disease	4.7	6.7	5.3	5.0	5.8	5.4
Diabetes mellitus	16.2	24.9†	19.0	6.9	21.3†	12.9
Depression	4.7	2.1*	3.9	9.4	3.7*	7.0
Osteoporosis	2.2	0.9	1.8	24.3	7.2*	17.2

Values for age are means ± SD; n, no. of subjects. *$P < 0.05$; †$P < 0.01$, black vs. white within gender.

Table 2. *Baseline body composition characteristics of participants of the Health, Aging, and Body Composition Study*

	Men			Women‡		
	White (n = 684)	Black (n = 330)	All (n = 1,014)	White (n = 598)	Black (n = 428)	All (n = 1,026)
Body height, m	1.73 ± 0.06	1.73 ± 0.07	1.73 ± 0.06	1.60 ± 0.06	1.60 ± 0.06	1.60 ± 0.06
Body mass index, kg/m^2	26.9 ± 3.7	27.2 ± 4.2	27.0 ± 3.9	25.9 ± 4.4	29.4 ± 5.6†	27.3 ± 5.2
Total body mass, kg	80.7 ± 12.1	81.6 ± 13.8	81.0 ± 12.7	65.9 ± 12.0	75.0 ± 14.4†	69.7 ± 13.8
Leg lean soft-tissue, kg	17.0 ± 2.3	18.3 ± 2.8†	17.5 ± 2.6	11.8 ± 1.9	13.9 ± 2.4†	12.7 ± 2.4
Arm lean soft-tissue, kg	6.5 ± 1.0	7.3 ± 1.2†	6.8 ± 1.1	3.7 ± 0.6	4.6 ± 0.8†	4.1 ± 0.8
Appendicular lean soft tissue, kg	23.5 ± 3.2	25.6 ± 3.8†	24.2 ± 3.5	15.5 ± 2.4	18.5 ± 3.1†	16.8 ± 3.1
Trunk lean soft tissue, kg	27.8 ± 3.5	27.1 ± 3.6†	27.6 ± 3.5	19.7 ± 2.7	20.9 ± 2.9†	20.2 ± 2.8
Total fat-free body mass, kg	57.2 ± 6.8	59.1 ± 7.6†	57.8 ± 7.2	39.8 ± 5.2	44.5 ± 6.2†	41.7 ± 6.1
Leg fat, kg	7.0 ± 2.1	7.4 ± 2.4†	7.1 ± 2.2	9.8 ± 3.0	11.6 ± 3.8†	10.5 ± 3.5
Arm fat, kg	2.7 ± 0.8	2.8 ± 1.0	2.7 ± 0.9	3.2 ± 1.1	3.9 ± 1.4†	3.5 ± 1.3
Appendicular fat, kg	9.7 ± 2.8	10.1 ± 3.2*	9.8 ± 2.9	12.9 ± 3.8	15.4 ± 5.0†	14.0 ± 4.5
Trunk fat, kg	12.6 ± 4.2	11.2 ± 4.4†	12.2 ± 4.3	12.2 ± 4.5	13.9 ± 5.0†	13.0 ± 4.8
Total body fat, kg	23.5 ± 6.7	22.5 ± 7.5*	23.2 ± 7.0	26.1 ± 7.8	30.5 ± 9.4†	27.9 ± 8.7

Values are means ± SD; n, no. of subjects. *$P < 0.05$; †$P < 0.01$, black vs. white within gender. ‡All body composition measures were different between men and women ($P < 0.01$) except body mass index.

mass was observed, both at the trunk and the extremities, suggesting that lean mass loss is partly matched by fat mass gain in older men.

Among women, arm lean soft tissue mass increased, whereas leg lean soft tissue mass decreased, resulting in no apparent change in appendicular lean soft tissue after 2 yr of follow-up. Trunk lean soft tissue and total body fat-free mass decreased after 2 yr of follow-up. Among women, only small changes in total body fat mass were observed after 2 yr. The loss of lean mass and the gain in fat mass were greater in men compared with women. It should be noted that in both men and women the relative change in lean mass after 2 yr of follow-up was generally <1%. Moreover, the variability in this change, as indicated by the standard deviations, was large.

No racial differences in total body mass change were observed (Table 4). In addition, no racial differences were observed in change in body composition after 1 yr of follow-up. After 2 yr of follow-up, blacks experienced a greater decline in leg lean soft tissue mass and appendicular lean soft tissue mass compared with whites. Among men, blacks had a greater loss of trunk lean soft tissue and total body fat-free mass compared with whites.

We investigated whether gender or race differences in the 2-yr change in appendicular lean soft tissue mass could be explained by differences in age, study site, physical activity, smoking status, oral estrogen use (women only), and health status. After adjustment for these potential confounders and race, the loss of appendicular lean soft tissue mass remained greater in men [−232 ± 43 (SE) g] compared with women (−56 ± 44 g; $P < 0.0001$). Moreover, after adjustment for the potential confounders, blacks still experienced a greater loss of appendicular lean soft tissue mass than whites. For men the change was −179 ± 69 (SE) g in whites and −317 ± 71 g in blacks ($P = 0.07$); for women the change was +22 ± 55 g in whites and −83 ± 60 g in blacks ($P = 0.06$).

We categorized the black and white men and women into three groups on the basis of their 2-yr change in appendicular lean soft tissue mass, our indicator of appendicular skeletal muscle mass. We used a cutoff point of 3% on the basis of the reported coefficient of variation for DXA soft tissue. Overall, 27.3% of the men and 25.4% of the women experienced a loss in appendicular lean soft tissue according to our criteria. Black men tended to be more likely to lose >3% appendicular lean soft tissue than white men ($P = 0.08$; Fig. 1).

The relationship between change in appendicular lean soft tissue mass categories during 2 yr of follow-up

Table 3. *Change in body composition as measured by dual-energy X-ray absorptiometry in the Health, Aging, and Body Composition Study*

	Men				Women			
	1-yr Change		2-yr Change		1-yr Change		2-yr Change	
	Means ± SD	%	Means ± SD	%	Means ± SD	%	Means ± SD	%
Total body mass, g	−139 ± 2,695	−0.1	−240 ± 3,511*	−0.3	−217 ± 2,551†	−0.3	−302 ± 3,452†	−0.4
Leg lean soft tissue, g	−78 ± 727†	−0.4	−162 ± 831†	−0.8	+25 ± 638‡	+0.3	−61 ± 710†‡	−0.3
Arm lean soft tissue, g	−25 ± 330*	−0.3	−37 ± 383†	−0.4	−11 ± 246	−0.1	+19 ± 269*‡	+0.7
Appendicular lean soft tissue, g	−103 ± 916†	−0.4	−200 ± 1,080†	−0.8	+14 ± 762‡	+0.2	−41 ± 846‡	−0.1
Trunk lean soft tissue, g	−120 ± 1,067†	−0.4	−360 ± 1,170†	−1.2	−49 ± 864	−0.1	−146 ± 982†‡	−0.6
Total body fat-free mass, g	−246 ± 1,619†	−0.4	−639 ± 1,955†	−1.1	−52 ± 1,348‡	−0.1	−262 ± 1,575†‡	−0.6
Appendicular fat, g	+118 ± 766†	+1.4	+253 ± 946†	+2.8	−5 ± 968‡	+0.1	+63 ± 1,214‡	+0.6
Trunk fat, g	−34 ± 1,263	+0.2	+141 ± 1,559†	+1.7	−162 ± 1,194†‡	−1.1	−98 ± 1,545*‡	−0.4
Total body fat, g	+107 ± 1,936	+0.7	+399 ± 2,409†	+2.0	−165 ± 1,970†‡	−0.5	−40 ± 2,595‡	+0.1

*$P < 0.05$; †$P < 0.01$ (paired t-test). ‡$P < 0.01$, women vs. men.

Table 4. *Racial differences in 2-yr change in body composition as measured by dual-energy X-ray absorptiometry in the Health, Aging, and Body Composition Study*

	Men				Women			
	White		Black		White		Black	
	Means ± SD	%	Means ± SD	%	Means ± SD	%	Means ± SD	%
Total body mass, g	−99 ± 3,297	−0.1	−533 ± 3,906	−0.6	−141 ± 2,970	−0.1	−529 ± 4,022	−0.7
Leg lean soft tissue, g	−118 ± 770	−0.6	−252 ± 939*	−1.3	−8 ± 613	+0.1	−133 ± 822†	−0.9
Arm lean soft tissue, g	−27 ± 374	−0.3	−60 ± 401	−0.7	+13 ± 245	+0.5	+28 ± 230	+0.9
Appendicular lean soft tissue, g	−145 ± 1,006	−0.5	−312 ± 1,212*	−1.2	+5 ± 738	+0.2	−105 ± 974*	−0.5
Trunk lean soft tissue, g	−302 ± 1,146	−1.0	−480 ± 1,212*	−1.7	−143 ± 880	−0.6	−151 ± 1,112	−0.7
Total body fat-free mass, g	−532 ± 1,851	−0.9	−860 ± 2,139*	−1.4	−214 ± 1,365	−0.5	−331 ± 1,828	−0.7
Appendicular fat, g	+275 ± 890	+3.0	+208 ± 1,053	+2.2	+128 ± 1,051	+1.2	−29 ± 1,408	−0.2
Trunk fat, g	+169 ± 1,574	+2.9	+84 ± 1,528	+1.3	−52 ± 1,374	+0.1	−164 ± 1,755	−0.9
Total body fat, g	+433 ± 2,312	+2.1	+327 ± 2,600	+1.7	+73 ± 2,269	+0.5	−198 ± 2,988	−0.6

*$P < 0.05$; †$P < 0.01$, black vs. white within gender.

and change in total body mass categories during the same follow-up period is shown in Fig. 2. Those who lost >3% of total body mass ($n = 215$ men and $n = 246$ women) were also more likely to have lost >3% of appendicular lean soft tissue mass ($P = 0.001$). These data show that weight loss is associated with loss of appendicular lean soft tissue in older men and women. The correlation coefficient between change in total body mass and change in appendicular lean soft tissue mass ranged from +0.58 to +0.70 ($P < 0.0001$) in the four gender and race groups. However, among those who had a stable or gain in total body mass, still >15% of men and women experienced a loss in appendicular lean soft tissue mass according to our criteria.

We also investigated whether the relative composition of the change in total body mass was different by gender or race. We calculated the percentage of the total body mass change consisting of appendicular lean soft tissue in participants who lost or who gained >3% total body mass (Fig. 3). Among men who lost total body mass, black men tended to lose more appendicular lean soft tissue (28.8%) than white men (24.1%, $P = 0.08$). A similar race difference was observed in women (black women 17.9% and white women 12.7%; $P = 0.04$). Men relatively lost more appendicular lean soft tissue compared with women ($P = 0.0001$). No gender and/or race differences were observed in the relative composition of the gain in total body mass. In all four groups, the gain consisted of 15–20% appendicular lean soft tissue ($P > 0.2$).

DISCUSSION

The results from this large prospective study in men and women aged 70–79 yr indicate that changes in body composition during a 1- to 2-yr follow-up could be detected by using DXA. The changes were generally <1–2%, and the variability of this change was high. Because the Health ABC Study used strict short-term and long-term quality control procedures, this variability is likely to be mainly interindividual variability. The overall small change and high variability have clear implications for the development of intervention studies. Our data will enable power calculations for the

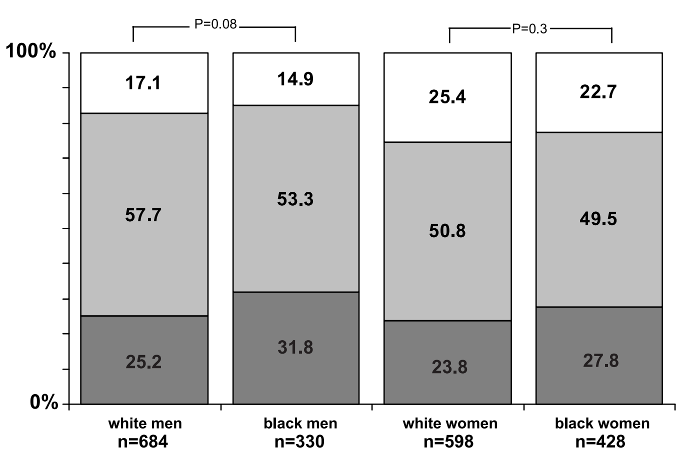

Fig. 1. Prevalence of 2-yr change in appendicular lean soft tissue mass (ALST) as measured by dual-energy X-ray absorptiometry in the Health, Aging, and Body Composition Study. Values are percentages; n, no. of subjects. Black bars, loss >3%; gray bars, stable; open bars, gain >3%. Differences by race were tested by using the χ^2 test.

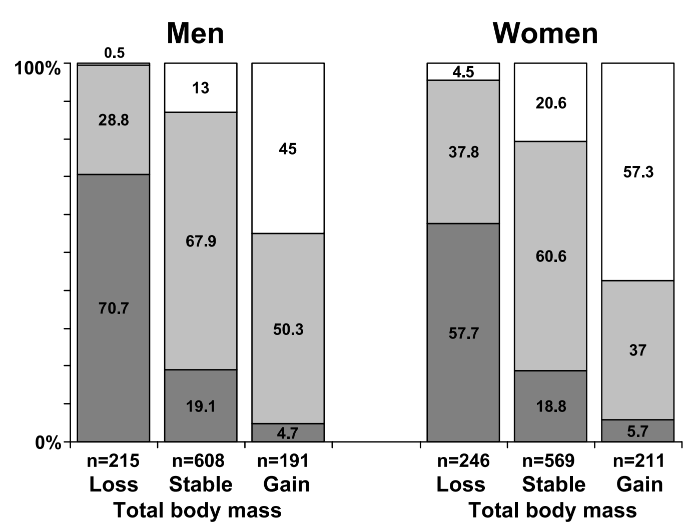

Fig. 2. Prevalence of >3% loss (black bars), stable (gray bars), or >3% gain (open bars) of ALST according to categories of 2-yr change in total body mass (loss >3%, stable, gain >3%) as measured by dual-energy X-ray absorptiometry in the Health, Aging, and Body Composition Study. Values are percentages; n, no. of subjects.

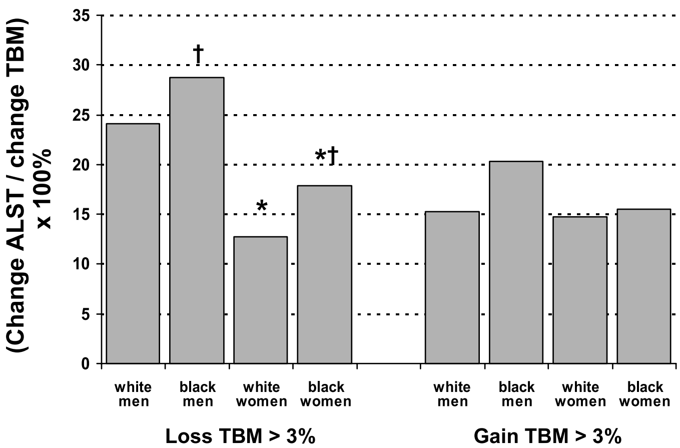

Fig. 3. Percentage of change in total body mass (TBM) that consisted of ALST in participants with a loss or gain in TBM >3% during a 2-yr follow-up in the Health, Aging, and Body Composition Study. $*P < 0.05$, women vs. men within race. $\dagger P < 0.05$, black vs. white within gender.

development of trials in older men and women aimed to favorably change body composition.

Weight change was clearly associated with change in appendicular lean soft tissue. Our results support the findings by Forbes (5) showing that change in fat-free mass, as measured by ^{40}K in 20 young persons followed for 21–38 yr, was strongly correlated with weight change ($r = 0.73$). Although these findings suggest that weight loss could be used as a clinical marker of sarcopenia in older persons, our study also showed that among those who had a stable total body mass or gain in total body mass, >15% of men and women still experienced a loss in appendicular lean soft tissue mass according to our criteria. Even if no changes in body weight are observed, a loss of appendicular lean soft tissue mass may still have occurred. Accurate assessment of body composition remains necessary when body composition changes are important and expected. The strong correlation between weight change and change in appendicular lean soft tissue mass does imply that the effect of an intervention developed to increase appendicular lean soft tissue mass can only be interpreted correctly if changes in body weight are taken into account. For example, the true increase in appendicular lean soft tissue mass due to an exercise intervention could be underestimated if the intervention would also cause a greater weight loss in the intervention group compared with the placebo group. Adjustment for weight change seems to be necessary to obtain the net effect of an intervention on body composition parameters.

Sex and race differences in body composition have been frequently reported (1, 10). Our baseline data confirm that men and blacks have more appendicular lean soft tissue than women and whites. However, much less is known about potential sex and race differences in body composition change with aging. In our study, men lost a greater absolute amount of lean mass and gained more fat mass compared with women, which supports the findings by Gallagher et al. (9). Furthermore, among participants who lost >3% of total body mass during 2-yr follow-up, men lost relatively more appendicular lean soft tissue than women. These results are consistent with the data from Forbes (5), showing a slope difference in the relationship between body weight change and change in fat-free mass between men and women: men lose more fat-free mass compared with women with similar weight loss. Our study extends these findings by showing a race difference in body composition change. Blacks lost more lean mass compared with whites but had a similar change in fat mass. Moreover, among participants who lost >3% of total body mass, blacks lost relatively more appendicular lean soft tissue than whites. These results show that both in absolute and relative terms, men and blacks lose more lean mass than women and whites. This suggests that men and blacks may be more prone to muscle loss.

The results of the study differed according to the specific body composition variable that was used as the outcome. For example, in women after 2 yr of follow-up, the amount of appendicular lean soft tissue mass did not change, whereas trunk lean soft tissue mass and total body fat-free mass declined. The increase in arm lean soft tissue mass counteracted the decrease in leg lean soft tissue mass, resulting in no observed change in appendicular lean soft tissue. This example indicates the importance of reporting body composition change of the total body as well as the separate body regions.

Several potential limitations of the study should be discussed. The participants included in the analyses were well functioning at baseline and needed to have complete body composition assessments after 1 and 2 yr. Disabled and less healthy persons are more likely to experience weight loss. The observed change in body composition in the present study may be biased and is likely to be underestimated. Second, we used the DXA method to assess change in body composition. The validity of the DXA method has been questioned and potential errors associated with tissue thickness and hydration status have been discussed (14, 18, 21). A theoretical study, however, showed that overhydration up to 5% will result in a small and undetectable error in body fat (19). In addition, most recent studies using new types of scanners and updated software (11, 12, 15) support the ability of DXA to measure small changes in body composition. A prospective validation study in obese persons losing weight, conducted by our group and using the DXA QDR 4500A scanner, supports these findings (25). Furthermore, a recent study in 76 postmenopausal women followed for 1 yr showed that DXA was a more sensitive method for assessing small changes in body composition compared with underwater weighing and a multicomponent model (12). Third, because no definition of sarcopenia on the basis of prospective data has been developed, we used the cutoff point of 3% to identify persons who lost appendicular lean soft tissue. The conclusions of the study did not markedly change when we varied this cutoff between 2 and 5%. Although based on smaller group sizes, the race and gender differences in relative loss of appendicular lean soft tissue were most striking when we used the cutoff of 5%, indicating that the presented conclusions may be conservative. Last, we investigated the change in body composition after 1 and 2 yr, a time period used in most intervention studies. Future studies using longer follow-up time will enable us to investigate whether men and blacks are more prone to sarcopenia. In addition, these studies should focus on potential determinants of sarcopenia, including (changes in) health status, endocrine factors, physical activity, and other lifestyle factors.

In conclusion, the mean 1- to 2-yr change in body composition measured by DXA in well-functioning men and women aged 70–79 yr was 1–2% with a high variability. Weight change was strongly associated with change in appendicular lean soft tissue mass. Loss of appendicular lean soft tissue mass was greater in men compared with women, and greater in blacks compared with whites, suggesting that men and blacks are more prone to muscle loss. Longitudinal studies with a longer follow-up time should determine whether men and blacks are at a greater risk for sarcopenia.

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