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# Association of fitness with changes in body composition and muscle strength

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## Abstract

**Objectives—**This study examined the association of physical fitness, as assessed by ability and time to complete a 400-meter walk, on changes in body composition and muscle strength over a subsequent 7-year period.

**Design—**Prospective observational cohort study

**Setting—**Memphis, Tennessee and Pittsburgh, Pennsylvania

**Participants—**2,949 black and white men and women aged 70-79 participating in the Health, Aging and Body Composition (Health ABC) study.

**Measurements—**Body composition (fat and bone-free lean mass) was assessed by dual-energy x-ray absorptiometry in years 1-6, and 8. Knee extension strength was measured with isokinetic dynamometry and grip strength with isometric dynamometry in years 1,2,4,6, and 8.

**Results—**Compared to very fit men and women at baseline, less fit people had a higher weight, higher total percent fat, and lower total percent lean mass ($p<0.01$). Additionally, the least fit lost significantly more weight, fat mass, and lean mass over time compared to the very fit ($p<0.01$).

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**Authors contributions**: AK conceptualized the idea, analyzed the data and wrote the first draft of the paper; MV and EMS contributed to the data analyses, interpreted the data and contributed to drafts of the article; BY and DBA contributed to the statistical analyses, interpreted the data and reviewed drafts of the paper; ABN was responsible for the data collection, as principal investigator at the Pittsburgh study site, interpreted the data, and reviewed drafts of the paper. JThME, AVS, and SS interpreted the statistical analyses and reviewed drafts of the paper; TBH (project office at NIA) contributed to the conceptualization of the idea, interpreted the data and contributed to drafts of the article.

**Conflict of interest disclosures**: none

Very fit people had the highest grip strength and knee extensor strength at baseline and follow-up; the decline in muscle strength was similar in every fitness group.

**Conclusions—**Low fitness in old age was associated with greater weight loss and loss of lean mass relative to having high fitness. Despite having lower muscle strength, the rate of decline in the least fit persons was similar to the most fit. In clinical practice, a long distance walk test as a measure of fitness might be useful to identify people at risk for these adverse health outcomes.

### Keywords

body composition; aging; fitness; muscle strength; muscle mass

## INTRODUCTION

Aging is associated with changes in body composition, a tendency to gain fat mass and lose lean tissue, both bone and muscle, even when weight does not change.[1-3] These age-related changes in body composition have been linked to increased risk of morbidity, disability, and mortality.[4] For example, loss of muscle mass may lead to functional impairment and physical disability.[5,6] There is a concomitant loss of strength and muscle quality with age [7,8] which contributes to decline in physical function and disability.[9]

Factors that cause loss of lean mass and muscle strength with increasing age are not well understood, but some evidence suggests that physical fitness may be important. For example, master athletes also lose muscle mass with age, although at slower rate than non-trained persons.[10] Endurance-oriented walking tests, such as the Long Distance Corridor Walk (LDCW), have been used to assess exercise capacity in older persons. The 400 meter walk component of the Long Distance Corridor Walk (LDCW) has been used to assess fitness in older persons. It provides a valid estimate of peak VO2 in older adults. [11] Furthermore, it has been strongly associated with mortality, cardiovascular disease, mobility limitation, and disability in older adults.[12-14] A recent cross-sectional study showed that muscle strength and power are related to the 400-meter time.[15] It is, however, unknown whether the ability and time to walk 400 meters predicts change in body composition and loss of lean mass and muscle strength in particular.

This study aims to examine the association of physical fitness as assessed by ability and time to complete a 400-meter walk on changes in body composition and muscle strength over a subsequent 7-year period.

## METHODS

### Study population

The Health ABC study is a longitudinal cohort study consisting of 3,075 initially well-functioning, 70- to 79-year old, black and white men and women. Participants were identified from a random sample of White Medicare beneficiaries and all age-eligible community-dwelling black residents in designated zip code areas surrounding Memphis, Tennessee, and Pittsburgh, Pennsylvania. Participants were eligible if they reported no difficulty in either walking one quarter of a mile, going up 10 steps without resting, or performing basic activities of daily living. Participants were excluded if they reported a history of active treatment for cancer in the prior three years, planned to move out of the study area in the next three years, or were currently participating in a randomized trial of a lifestyle intervention. Baseline data, collected between April 1997 and June 1998, included an in-person interview and a clinic-based examination, with evaluation of body composition, clinical and sub-clinical diseases, and physical functioning. Data on body composition were missing for 126 participants leaving 2,949 participants for the analyses with body composition. Muscle strength data were missing for 165 persons, resulting in 2,910 participants for the analyses with muscle strength. All participants signed written informed consent forms approved by the institutional review boards of the clinical sites.

## Measures

**Long Distance Corridor Walk (LDCW)—**The 400 meter walk test, a component of the LDCW, was used as measure of cardiorespiratory fitness in older adults,[11,16] therefore, the term 'fitness' in used here.

Participants were asked to walk for 2 minutes covering as much ground as possible. Following successful completion of this walk, participants were instructed to walk 400 meters (10 laps of 20 meters per segment (40 meters per lap)) as quickly as possible at a pace they could maintain.[12] Standard encouragement was given each lap. Persons with electrocardiogram abnormalities, elevated blood pressure (≥200/110 mmHg), resting heart rate higher than 110/min or less than 40/min, recent exacerbation of chest pain, shortness of breath, or recent cardiac event or procedure were excluded for medical safety (12.8% of original cohort). Heart rate was monitored before the test at rest and at recovery 2 minutes later, as well as during the test. The test was stopped if heart rate exceeded 135 bpm or if a participant reported chest pain or dyspnea during the test (11.8% of original cohort). Four categories of fitness were created: very fit: walk time <5 minutes, somewhat fit: walk time 5-<5.45 minutes, moderately fit: walk time 5.45-<7 minutes, and least fit: walk time≥7 minutes or stopped or excluded from the test. A time of more than 7 minutes to walk 400 meters equates to a cardiorespiratory fitness level of less than 12 ml $O_2$/kg/min,[11] the minimum level deemed necessary to cross an intersection.[17] The other 3 groups were based on tertiles of time to complete the 400 meter walk.

**Body composition—**Body weight was measured annually to the nearest 0.1 kg with a standard balance beam scale. Total body scans were acquired annually through year 8, with the exception of year 7, using fan-beam DXA (Hologic QDR 4500A) with DXA software (Hologic, Bedford, MA). Total fat mass, total bone-free lean mass, trunk fat and bone-free lean mass, and appendicular (arms and legs) fat and bone-free lean mass were assessed in years 1(baseline), 2, 3, 4 ,5 ,6 and year 8.

**Muscle Strength—**Handgrip strength (kg) was measured using a hand-held dynamometer (Jamar, TEC, Clifton, NJ). Two trials were performed on each hand. The maximum values of the right and the left hand were summed. Knee extension strength was measured concentrically at 60° per second on an isokinetic dynamometer (Kin-Com dynamometer, 125 AP; Chattanooga, TN). The right leg was tested unless there was a contra-indication such as joint replacement or knee pain. The maximum muscle torque (Newton meters, N-m) was calculated from the average of three reproducible and acceptable trials from a maximum of six. Participants with a systolic blood pressure ≥200 mmHg, diastolic blood pressure ≥110 mmHg, or who reported a history of cerebral aneurysm, cerebral bleeding, bilateral total knee replacement, or severe bilateral knee pain were excluded from testing (12.7% of original cohort). Muscle strength was assessed in years 1, 2, 4, 6 and 8. The strength measures were normalized by body weight.

**Diseases—**Presence of lung, heart, and cerebrovascular disease, diabetes mellitus, osteoarthritis, and cancer at baseline was determined using standardized algorithms considering self-report, use of specific medications, and clinical assessments. Depressed mood at baseline was assessed with the Center for Epidemiologic Studies Depression (CES-D) scale. A cut-off score of 16 was used as a criterion for clinically significant depressive symptoms.[18] Cognitive impairment at baseline was defined as a Modified Mini-Mental State Examination (3MS) score less than 78.[19]

### Statistical Analyses

The chi square test for categorical variables and an analysis of variance for continuous variables were used to examine differences in baseline characteristics according to LDCW completion status and time to walk 400 meters.

Multilevel analyses, using linear mixed models in SPSS, were used to examine the association between completion status and time to walk 400 meters and change in body composition and muscle strength. A multilevel analysis has the advantage that it is a suitable technique for repeated measurement analyses and it allows us to include all persons with at least one measurement of body composition or muscle strength. We defined a two-level hierarchy to form random regression models to describe individual variability in longitudinal change in body composition and strength. The first level was defined by age, as the longitudinal time variable, and the second level by respondent. Models included the 400-m walk categories as well as the interaction between the 400-m walk and age to determine how the association of the 400-m walk with body composition and strength changes with time. The models adjusted for age, age$^2$, race, site, and the interactions race*age, and site*age. The intercepts and slope (interaction with age) of each model are presented. Analyses were performed using SPSS, version 14.0 (SPSS Inc., Chicago, IL).

## RESULTS

Baseline characteristics according to fitness level for men and women are presented in table 1. Results are shown for men and women separately because of a significant interaction between fitness level and sex. There were no race-related interactions. In both men and women, the very fit group had a lower mean age and a higher percentage was white than the less fit groups. Very fit persons had a lower weight, lower BMI, lower total percent fat and a higher total percent lean at baseline compared to the other fitness groups. Grip strength and knee extensor strength was lowest in the least fit group in both men and women.

Table 2 shows the results of the multilevel analyses according to fitness level. The intercept is the parameter estimate at baseline of each body composition measure in the moderately, somewhat, and least fit compared to the very fit, which serves as the reference group. For example in men, weight in the least fit group was 4 kg more than the most fit. The slope is the coefficient of the fitness category*age interaction term, indicating the effect of longitudinal time on, for example, weight in the poorer fitness categories in comparison to the most fit. For example, least fit men lost on average 0.26 kg more weight per year than very fit men ($p<0.01$).

Compared to very fit people, less fit men and women had significantly more fat at baseline. Least fit men and somewhat fit and least fit women lost significantly more fat mass over time than very fit men and women. When we additionally adjusted for weight at baseline and during the follow-up, the differences in fat mass decreased but remained statistically significant. The differences in slope also decreased and were not significant anymore in men while least fit women still lost significantly more fat mass compared to very fit women ($p=0.02$) (results not shown). Total lean mass was higher among somewhat fit and least fit people, however, the percent lean mass was significantly lower and these groups lost significantly more lean mass over time compared to the very fit people (p<.0.01). The results for weight, fat mass and lean mass are also shown in figure 1. Results of trunk and appendicular fat and lean mass were similar to the patterns found for total fat and lean mass. After adjustment for weight at baseline and follow-up slope differences for lean mass decreased for men but remained significant in somewhat fit men (p=0.02). Least fit women still lost significantly more lean mass compared to their very fit counterparts (p=0.02), independent of changes in weight (results not shown).

Table 3 and figure 2 show the associations between fitness level and changes in muscle strength. Compared to the very fit, less fit people had significantly lower grip strength and knee extensor strength per kilogram of body weight. Slope differences were not statistically significant, meaning that the rate of decline in muscle strength was similar in every fitness group. To determine whether the differences in strength are due to differences in lean mass, we additionally adjusted for lean mass at baseline and follow-up. The pattern remained the same with the lowest grip and knee extensor strength in the less fit groups at baseline and follow-up and a similar rate of decline in each fitness group (results not shown). Additionally, we examined the change in muscle quality which was calculated as normalized knee extensor strength divided by total lean mass of the tested leg. The pattern remained the same as in figure 2; the moderate and least fit had the lowest muscle quality but the rate of decline was the same in each fitness group (results not shown).

In additional analyses we adjusted for prevalent diseases at baseline. The association between fitness level and body composition and fitness and muscle strength remained very similar (not tabulated).

## DISCUSSION

In this longitudinal study of well-functioning older adults, we found that low fitness levels, as indicated by slower walking time or inability to complete the 400 meter walk test, was related to unfavorable changes in body composition. In older adults, the time and ability to walk 400 meters has been shown to be a good indicator of aerobic capacity [11] and has previously been associated with mortality, cardiovascular disease, and mobility limitation and mobility disability.[13,20] We show that the most fit from a cardiovascular perspective had a lower weight, lower total percent body fat, greater total percent lean and greater muscle strength. Findings suggest that this initial fitness advantage not only persists with increasing age, but also conditions a better decline profile over time.

This study showed that, on average, people lose weight as they age no matter what their baseline fitness level.[21] Until the age of about 75 it was a gradual weight loss where people still gained some fat mass, especially in men. A much steeper decline in weight loss was found after the age of 75 accompanied by the loss of fat mass. We found a linear decline in lean mass across the whole age range in each fitness group in both men and women. Also, both men and women lost considerable muscle strength. These age-related changes in body composition may underlie age-related diseases and disability.[22] Especially the loss of lean mass and muscle strength, or sarcopenia, in old age has been strongly associated with disability.[5,23] Although sarcopenia occurs with normal aging it is important to identify factors that may protect against rapid decline in muscle mass and strength. Weight loss accelerates sarcopenia [2] but sarcopenia is also present in weight stable individuals.[1]

The important finding of this study is that in a relatively healthy group of older persons, people who were very or moderately fit at baseline preserved more total lean mass than the somewhat fit and the least fit. The greater loss in total lean mass in the somewhat and least fit people was accompanied by lower loss in percentage lean mass over time. Less fit people had significantly higher baseline overall weight and lower total lean mass. After about the age of 75, percent lean increased in all fitness groups, but increased more in the less fit groups due to their greater loss in fat mass. Muscle quality was lowest in the less fit groups at baseline an follow-up.The loss of lean mass with aging might be due to the decreased ability to respond to anabolic stimuli, e.g. diet and exercise, due to hormonal and immunological changes.[24] This may partly explain why people with a faster walking time on the 400 meter walk test better conserved muscle mass than those with a slower walking time or who were not able to complete the walk. Not only the loss of lean mass but also the loss of fat mass might be an important with respect to health outcomes. The loss of fat mass in the least fit may reflect age-associated loss of homeostatic control of weight. Future work should evaluate whether our observations reflect energy dysregulation. Future studies should evaluate the consequences of the loss of fat mass and changes in fat distribution in very old age.

Muscle strength was highest among the very fit people at every age although the rate of decline was similar in each fitness group. The decline in strength was independent of lean mass. Also, similar results were found for muscle quality. The equal rate of decline in strength and muscle quality in the four fitness groups suggests that the difference in muscle strength due to a different fitness level occurred before the age of 70. Reversed causation cannot be ruled out. A slower walking time on the 400 meter walk test may have been the result of reduced muscle strength. A study showed that muscle strength and power are important predictors of the time to walk 400 meters.[15] Similarly, obesity may have affected the ability and time to complete the 400 meter walk test. A recent study shows that obesity is a risk factor for walking limitation.[25] Future studies are needed to explore if physical fitness earlier in life predicts changes in body composition. Additionally, the effect of body composition and strength on changes in fitness should be evaluated.

Factors that predict age-related changes in body composition are not well-understood. In the present study we show that fitness in one of those factors. Even in persons, aged 70 and over, exercise capacity might be a potential modifiable risk factor for interventions to preserve lean mass and maintaining muscle strength in old age. Increasing physical activity is the primary determinant of fitness and thus may increase cardiorespiratory fitness level.[26] The unfavorable changes in body composition in the least fit may cause declines in physical function and the onset of disability and premature death and may therefore (partly) explain the association between fitness and cardiovascular disease, mobility disability, and mortality.[12-14,20]

This study has some limitations. First, study participants were 70 to 79 years old and well-functioning at baseline, so the results can not be generalized to other groups. Second, using multilevel analyses we included all measurements of body composition and muscle strength and did not exclude people with one or more missing observations. Persons died during the follow-up and people had missing data because they were not able to come to the clinic for the assessments because of health problems and the best approach to analyzing such data remains open to question. People with full data on body composition on all measurements (n=1279, 43.4%) were significantly more fit compared to persons with one or more missing observations (data not shown). It is likely that body composition changes more unfavorably in people with missing follow-up assessments due to health problems; therefore we may have underestimated the association between fitness level and changes in body composition and muscle strength. Third, results did not change after adjustment for chronic diseases at baseline, possibly due to ascertainment bias in the panel of diseases considered or the existence of sub-clinical diseases. Also, we did not determine the impact of incident disease over time.

In summary, low fitness in old age was associated with greater weight loss and loss of lean mass relative to having high fitness. Additionally, least fit persons had a lower grip strength and knee extensor strength than persons with a higher fitness level at all ages; the rate of decline in the least fit was similar to the most fit. While change over time is important, the level of fitness coming into old age is an important predictor of maintaining lean mass and greater strength in old age. In clinical practice, a long distance walk test as a measure of fitness might be useful to identify people at risk for these adverse health outcomes.

## Acknowledgments

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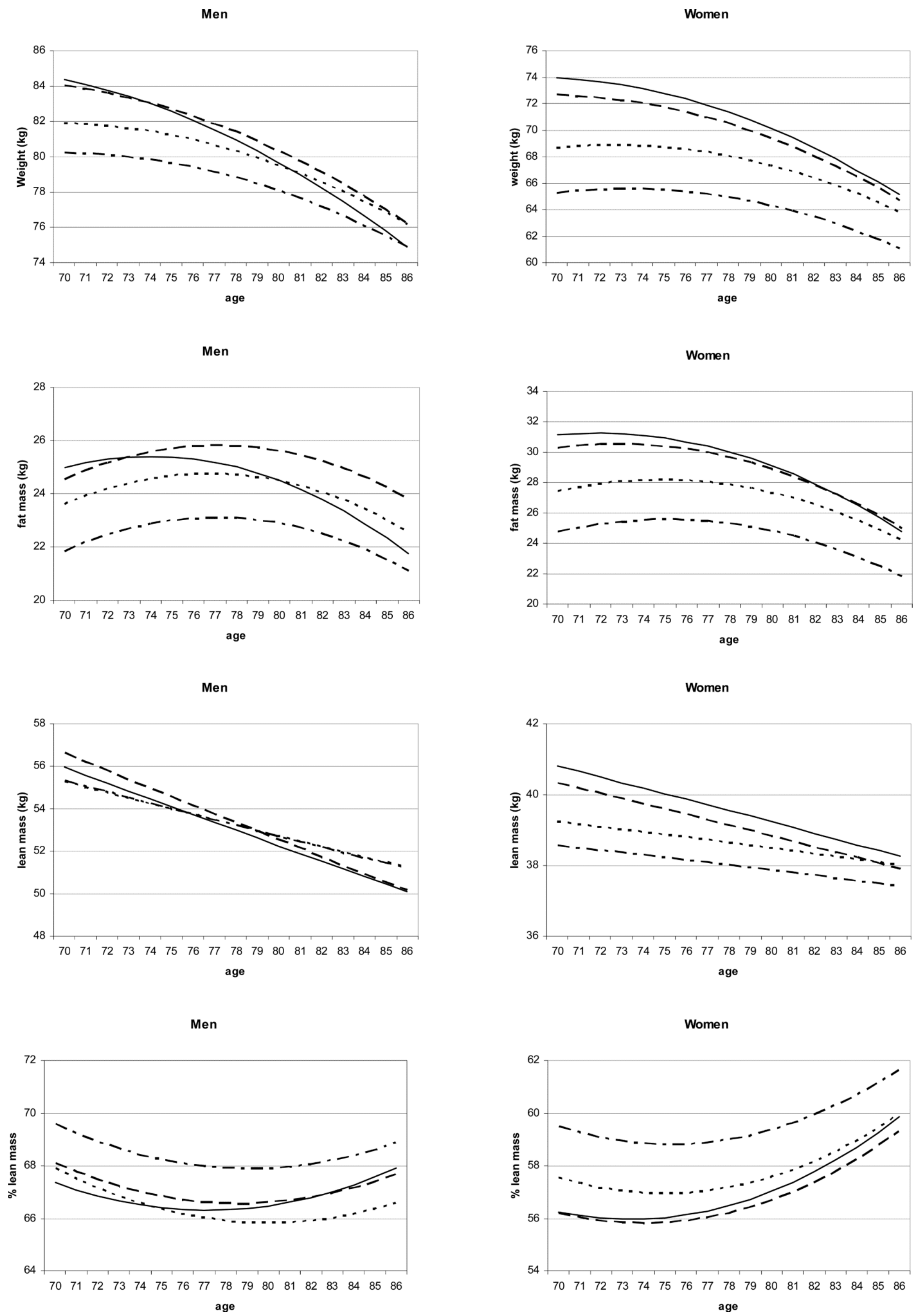


**Figure 1.**

Longitudinal course of weight, fat mass, and lean mass according to fitness level * Adjusted for age, race, site, age$^2$, race*age, and site*age

Figure legend:

Very fit

Moderately fit

Somewhat fit

Least fit

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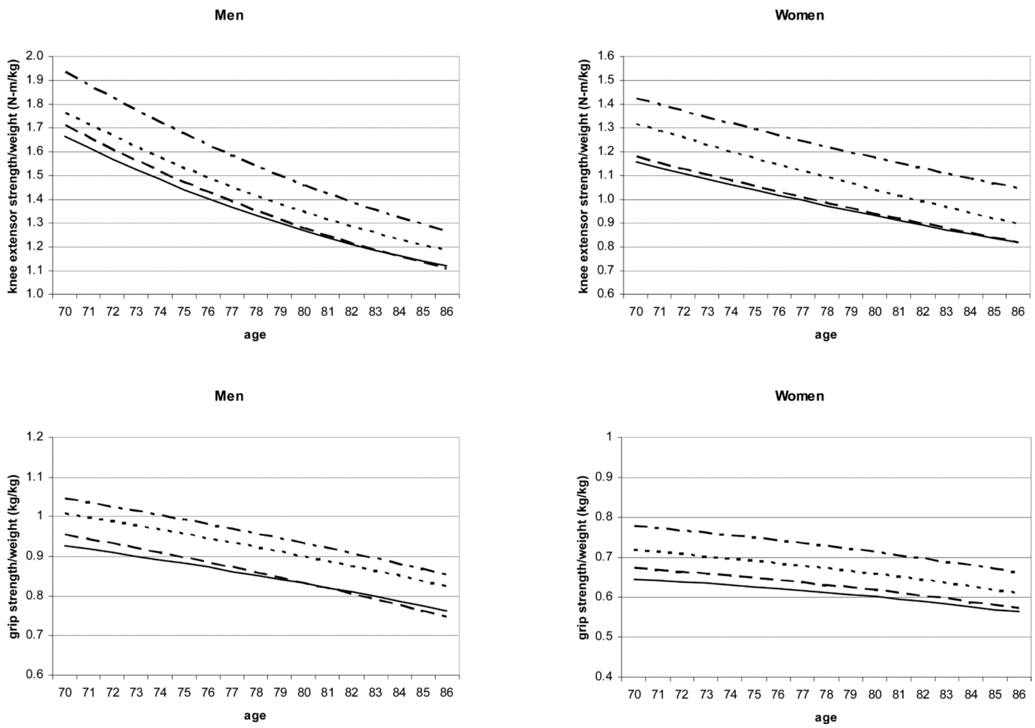


**Figure 2.**

Longitudinal course of grip strength and knee extensor strength according to fitness level * Adjusted for age, race, site, age$^2$, race*age, and site*age

Figure legend:

Very fit

Moderately fit

Somewhat fit

Least fit

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**Table 1**

Baseline Characteristics According to Fitness Level

| Characteristics | Men Very fit n=496 | Men Moderately fit n=350 | Men Somewhat fit n=256 | Men Least fit n=327 | Men p-value | Women Very fit n=241 | Women Moderately fit n=382 | Women Somewhat fit n=351 | Women Least fit n=546 | Women p-value |
|---|---|---|---|---|---|---|---|---|---|---|
| Age (yrs), mean (SD) | 73.8(2.8) | 74.3(2.8) | 74.6(2.8) | 74.6(2.9) | <0.01 | 73.2(2.4) | 73.8(2.9) | 74.2(2.9) | 74.4(2.9) | <0.01 |
| Race, white, % | 77.6 | 63.7 | 47.7 | 52.6 | <0.01 | 79.3 | 69.1 | 43.9 | 38.3 | <0.01 |
| Site, Memphis, % | 41.7 | 55.1 | 60.9 | 50.5 | <0.01 | 39.8 | 52.1 | 58.1 | 49.5 | <0.01 |
| Weight(kg), mean(SD) | 79.7(11.9) | 81.4(12.9) | 82.2(14.0) | 82.2(14.0) | 0.02 | 63.7(9.1) | 67.8(12.1) | 75.6(15.2) | 73.7(16.4) | <0.01 |
| BMI (kg/m$^2$), mean(SD) | 26.4(3.3) | 27.2(3.8) | 27.4(4.5) | 27.5(4.5) | <0.01 | 25.0(3.4) | 26.6(4.4) | 28.3(5.5) | 29.1(6.2) | <0.01 |
| Fat mass(kg), mean(SD) | 22.9(6.4) | 24.4(7.1) | 24.8(7.8) | 24.9(7.8) | <0.01 | 24.7(6.1) | 27.6(7.7) | 30.5(9.4) | 31.2(10.6) | <0.01 |
| Total percent fat(%), mean(SD) | 28.4(4.5) | 29.5(5.0) | 29.6(5.3) | 29.9(5.3) | <0.01 | 38.2(5.0) | 40.0(5.1) | 41.3(5.6) | 41.3(6.4) | <0.01 |
| Lean mass(kg), mean(SD) | 54.1(6.6) | 54.3(6.9) | 54.8(7.2) | 54.4(7.6) | 0.65 | 37.4(3.9) | 38.4(5.2) | 40.2(6.2) | 40.6(6.6) | <0.01 |
| Total percent lean(%), mean(SD) | 68.2(4.2) | 67.2(4.7) | 67.2(5.0) | 66.8(5.0) | <0.01 | 59.0(4.7) | 57.2(4.9) | 56.0(4.0) | 56.0(6.1) | <0.01 |
| Trunk fat mass(kg), mean(SD) | 12.4(4.0) | 13.1(4.5) | 13.1(4.8) | 13.3(4.9) | 0.02 | 11.8(3.6) | 13.2(4.5) | 14.3(5.3) | 15.0(5.7) | <0.01 |
| Trunk lean mass(kg), mean(SD) | 27.0(3.4) | 27.1(3.6) | 27.2(3.6) | 27.2(3.8) | 0.82 | 19.1(2.0) | 19.6(2.6) | 20.2(3.1) | 20.4(3.1) | <0.01 |
| Appendicular fat mass(kg), mean(SD) | 10.0(2.7) | 10.6(3.0) | 10.9(3.4) | 11.1(3.3) | <0.01 | 12.5(3.1) | 13.9(3.9) | 15.6(4.8) | 15.7(5.7) | <0.01 |
| Appendicular lean mass(kg), mean(SD) | 23.8(3.5) | 23.9(3.4) | 24.2(3.8) | 23.8(3.9) | 0.42 | 15.5(2.0) | 16.0(2.7) | 17.1(3.3) | 17.2(3.6) | <0.01 |
| Grip strength(kg), mean(SD) | 79.4(15.5) | 79.1(16.8) | 75.8(16.3) | 73.2(16.9) | <0.01 | 47.5(10.9) | 47.4(10.9) | 47.7(11.4) | 46.1(12.0) | 0.13 |
| Knee extensor strength(Nm), mean(SD) | 141.5(36.3) | 131.6(30.2) | 126.9(31.6) | 122.8(36.3) | <0.01 | 86.7(18.6) | 84.6(21.8) | 80.1(22.9) | 78.2(22.6) | <0.01 |

**Table 2**

Intercept and Slope of Body Composition According to Quartiles of Time to Complete the 400 m Walk and Completion Status

| | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| **400m walk** | **Intercept** | **p** | **Slope** | **p** | **Intercept** | **p** | **Slope** | **p** |
| **Weight (kg)** | | | | | | | | |
| Very fit | Ref | | Ref | | Ref | | Ref | |
| Moderately fit | 1.72 | 0.09 | -0.02 | 0.72 | 3.47 | <0.01 | -0.04 | 0.60 |
| Somewhat fit | 3.95 | <0.01 | -0.15 | 0.06 | 7.62 | <0.01 | -0.23 | <0.01 |
| Least fit | 4.43 | <0.01 | -0.26 | <0.01 | 9.00 | <0.01 | -0.29 | <0.01 |
| **Fat mass (kg)** | | | | | | | | |
| Very fit | Ref | | Ref | | Ref | | Ref | |
| Moderately fit | 1.79 | <0.01 | -0.02 | 0.70 | 2.72 | <0.01 | -0.02 | 0.76 |
| Somewhat fit | 2.71 | <0.01 | 0.00 | 0.99 | 5.69 | <0.01 | -0.15 | 0.02 |
| Least fit | 3.30 | <0.01 | -0.16 | <0.01 | 6.62 | <0.01 | -0.21 | <0.01 |
| **Total percent fat (%)** | | | | | | | | |
| Very fit | Ref | | Ref | | Ref | | Ref | |
| Moderately fit | 1.59 | <0.01 | -0.02 | 0.57 | 1.95 | <0.01 | -0.01 | 0.76 |
| Somewhat fit | 1.75 | <0.01 | 0.04 | 0.41 | 3.48 | <0.01 | -0.06 | 0.18 |
| Least fit | 2.37 | <0.01 | -0.07 | 0.06 | 3.57 | <0.01 | -0.10 | 0.03 |
| **Lean mass (kg)** | | | | | | | | |
| Very fit | Ref | | Ref | | Ref | | Ref | |
| Moderately fit | -0.05 | 0.93 | 0.01 | 0.85 | 0.67 | 0.16 | 0.00 | 0.87 |
| Somewhat fit | 1.44 | 0.02 | -0.15 | <0.01 | 1.84 | <0.01 | -0.08 | 0.01 |
| Least fit | 0.72 | 0.19 | -0.11 | <0.01 | 2.33 | <0.01 | -0.09 | <0.01 |
| **Total percent lean (%)** | | | | | | | | |
| Very fit | Ref | | Ref | | Ref | | Ref | |
| Moderately fit | -1.52 | <0.01 | 0.02 | 0.59 | -1.95 | <0.01 | 0.01 | 0.74 |
| Somewhat fit | -1.64 | <0.01 | -0.04 | 0.36 | -3.34 | <0.01 | 0.06 | 0.18 |
| Least fit | -2.32 | <0.01 | 0.08 | 0.04 | -3.34 | <0.01 | 0.09 | 0.03 |
| **Trunk fat mass (kg)** | | | | | | | | |
| Very fit | Ref | | Ref | | Ref | | Ref | |
| Moderately fit | 1.19 | <0.01 | -0.01 | 0.66 | 1.48 | <0.01 | -0.02 | 0.47 |

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| | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| **400m walk** | **Intercept** | **p** | **Slope** | **p** | **Intercept** | **p** | **Slope** | **p** |
| Somewhat fit | 1.82 | <0.01 | -0.02 | 0.64 | 2.86 | <0.01 | -0.10 | 0.01 |
| Least fit | 2.06 | <0.01 | -0.10 | <0.01 | 3.60 | <0.01 | -0.13 | <0.01 |
| **Trunk lean mass (kg)** | | | | | | | | |
| Very fit | Ref | | Ref | | Ref | | Ref | |
| Moderately fit | 0.14 | 0.60 | 0.01 | 0.75 | 0.35 | 0.14 | 0.00 | 0.85 |
| Somewhat fit | 0.98 | <0.01 | -0.08 | <0.01 | 0.88 | <0.01 | -0.04 | 0.01 |
| Least fit | 0.69 | 0.02 | -0.05 | 0.01 | 1.20 | <0.01 | -0.05 | <0.01 |
| **Appendicular fat mass (kg)** | | | | | | | | |
| Very fit | Ref | | Ref | | Ref | | Ref | |
| Moderately fit | 0.54 | 0.03 | 0.00 | 0.92 | 1.20 | 0.01 | 0.01 | 0.71 |
| Somewhat fit | 0.84 | <0.01 | 0.01 | 0.55 | 2.80 | <0.01 | -0.06 | 0.05 |
| Least fit | 1.12 | <0.01 | -0.04 | 0.07 | 3.01 | <0.01 | -0.08 | <0.01 |
| **Appendicular lean mass (kg)** | | | | | | | | |
| Very fit | Ref | | Ref | | Ref | | Ref | |
| Moderately fit | -0.24 | 0.38 | 0.01 | 0.72 | 0.26 | 0.29 | 0.00 | 0.97 |
| Somewhat fit | 0.30 | 0.33 | -0.06 | <0.01 | 0.89 | <0.01 | -0.03 | 0.03 |
| Least fit | -0.12 | 0.68 | -0.04 | 0.03 | 1.01 | <0.01 | -0.03 | 0.04 |

* Adjusted for age, race, site, race*age site*age, age*age

**Table 3**

Intercept and Slope of Muscle Strength According to Quartiles of Time to Complete the 400 m Walk and Completion Status

| | **Men** | | | | **Women** | | | |
|---|---|---|---|---|---|---|---|---|
| **400m walk** | **Intercept** | **p** | **Slope** | **p** | **Intercept** | **p** | **Slope** | **p** |
| **Grip strength/ weight (kg/kg)** | | | | | | | | |
| Very fit | Ref | | Ref | | Ref | | Ref | |
| Moderately fit | -0.04 | 0.03 | 0.0005 | 0.72 | -0.06 | <0.01 | 0.0006 | 0.73 |
| Somewhat fit | -0.09 | <0.01 | -0.0009 | 0.65 | -0.11 | <0.01 | 0.0009 | 0.59 |
| Least fit | -0.12 | <0.01 | 0.001 | 0.33 | -0.13 | <0.01 | 0.002 | 0.20 |
| **Knee extensor strength/weight (Nm/kg)** | | | | | | | | |
| Very fit | Ref | | Ref | | Ref | | Ref | |
| Moderately fit | -0.18 | <0.01 | 0.006 | 0.13 | -0.11 | <0.01 | -0.002 | 0.56 |
| Somewhat fit | -0.23 | <0.01 | 0.005 | 0.32 | -0.25 | <0.01 | 0.001 | 0.78 |
| Least fit | -0.28 | <0.01 | 0.008 | 0.06 | -0.27 | <0.01 | 0.003 | 0.56 |

* Adjusted for age, race, site, race*age site*age, age*age