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Clustering of strength, physical function, muscle and adiposity characteristics and risk of disability in older adults

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Abstract

Objectives—Strength, physical performance, adiposity and lean mass may be independent risk factors for disability in older adults. The aim of this study was to empirically identify groupings of these interrelated measures and test how such groupings may relate to disability risk.

Design—Prospective Health, Aging and Body Composition Study (Health ABC)

Setting—Two US clinical centers

Participants—1,263 women and 1,221 men

Measurements—Weight, strength (knee extension, grip); walking speed; chair stands; dual x-ray absorptiometry (fat and lean mass for total body, arm, and leg; percent fat); and thigh computed tomography scans (muscle area, muscle density). Analyses were stratified by sex. Factor analysis reduced these variables into a smaller number of components, and proportional hazards models assessed risk of major disability for the components identified.

Results—In both sexes, factor analysis reduced the 14 individual variables into three components that explained 76–77% of the data variance: Factor 1, an adiposity component, with strong loading by fat mass, weight and muscle density; Factor 2, a strength/lean body size component with strong loading by lean mass, weight and strength; Factor 3, a physical performance component with positive loading by walking speed and chair stands performance. Factor 1 (adiposity) and Factor 3 (performance), but not Factor 2 (strength/lean body size), were associated with disability over 6.1 ($\pm$ 2.6 SD) years.

Conclusion—Adiposity and physical performance constructs, but not the strength/lean body size construct, were associated with disability risk, suggesting that adiposity and performance should be considered as risk factors for disability.

Keywords

lean mass; muscle; strength; disability; sarcopenia

Introduction

Poor physical performance has been associated with an increased risk of disability in older adults.^{1–3} Additionally, some,^{4–7} but not all,^{8–10} reports suggest that there is an association between low lean mass (or sarcopenia) and disability or mobility limitations. Decreased muscle density, a marker of muscle fat infiltration or myosteatosis, has also been shown to be a risk factor for disability and hospitalization,^{11,12} and adiposity, including measures of BMI and percent body fat, also increases the risk of disability.^{13,14} These measures of strength, performance, lean mass, thigh muscle cross sectional area (CSA), muscle density and adiposity are known to be interrelated; however, empirical analyses of how these factors may cluster together have not previously been completed.

Both strength and muscle mass have been shown to decline with age;^{15–17} and declines in strength may be more rapid than declines in lean mass.¹⁷ Some exercise intervention studies have demonstrated a maintenance of muscle strength and density in spite of a concurrent loss of lean mass.¹⁸ Not all interventions that increase lean mass also increase muscle strength or physical performance: growth hormone increases lean mass without a concurrent increase in strength.¹⁹ Thus, it is unclear which adiposity, physical function, strength or lean mass factor alone, or which combination of factors, drive the association with increased disability risk, and whether these interrelated measures are markers of a smaller number of underlying factor(s).

The primary aim of this study was to identify groupings within 14 interrelated measures of muscle density, thigh muscle cross-sectional area, total body lean mass, arm lean mass, leg lean mass, grip strength, knee extension strength, weight, arm fat mass, leg fat mass, total body fat mass, percent fat mass, chair stands, and walking speed using factor analysis as a data reduction step. Factor analysis generates factors that are interpreted as underlying latent variables in the data. We hypothesized that factor analysis would generate four distinct factors: an adiposity/body size factor; a lean mass factor; a strength factor; and a physical performance factor. The second aim of these analyses was to determine whether the components identified by factor analysis were independently associated with an increased risk of major disability. We hypothesized that the adiposity/body size factor, the strength factor and the physical performance factor, but not the lean mass/muscle size factor, would be related to disability risk. These analyses were completed using data from the Health, Aging and Body Composition (Health ABC) Study.

Methods

Participants

Between March 1997 and July 1998, 3,075 black and white men and women aged 70 – 80 years were recruited to participate in the Health ABC study; characteristics of the cohort have been described elsewhere.²⁰ Medicare beneficiary listings were used to recruit in metropolitan areas surrounding Pittsburgh, PA and Memphis, TN. Eligibility criteria included: having no difficulty walking one-quarter of a mile, climbing 10 steps, or performing activities of daily living (transferring, bathing, dressing and eating); no history

of active treatment for cancer in the prior three years; and no plans to move from the area within three years.

Disability

In Health ABC, participants or a proxy were contacted every six months to ascertain disability status. Average follow-up time for this analysis was 6.1 ($\pm$ 2.6 SD, maximum 9) years. After the baseline exam, when a participant was unable or unwilling to return to the clinic, the participant was offered a home exam. If that was refused, a phone interview was obtained. If a participant could not be located or could not provide information, then proxy informants, nominated by the participant during the previously attended visit, provided information about the participant. Proxy informants were contacted by telephone. At each contact, participants (or their proxy) were queried about needing equipment to walk; needing assistance with three activity of daily living (ADL) measures (needing assistance getting out of a bed or chair; bathing; or dressing); or having a mobility disability (inability to walk ¼ mile or climb 10 steps). *Major disability* was defined as the presence of any of the following: ADL disability (needing assistance with rising from a bed or chair, bathing/showering or dressing); needing equipment to ambulate; and/or the presence of a mobility disability (inability to walk ¼ mile or climb 10 steps.). Time to disability was defined as the time from the baseline exam until the first visit at which the disability was first reported.

Muscle strength

Knee extension strength (maximal isokinetic torque, Newton-meters [Nm]) was measured using a KinCom 125 AP dynamometer (Chattanooga, TN) measured at 60 degrees per second; participants had six attempts to complete up to three reproducible and acceptable trials. The average maximal knee strength was analyzed. A number of participants had missing data for this measure due to medical conditions preventing testing or an incomplete test (N=398). Jamar dynamometers were used to assess grip strength (Sammons Preston Rolyan, Bolingbrook, IL, USA).²¹ Maximal strength from either of two trials per hand was analyzed. Grip strength exclusions included recent pain in their wrist or hand; or a history of surgery on the upper extremity in the three months prior to baseline (N=12).

Physical functioning

Usual walking pace over 6 meters was recorded (m/s); nine participants were missing this measure. Ability to rise from a chair once without using the arms to push off was assessed. If a participant could rise once, then ability and time to rise five consecutive times without the use of the arms (repeat chair stands) was assessed. Number of chair stands per second was calculated and analyzed. Participants unable to complete the single stand or the repeated stand test were considered unable to complete the repeated chair stands exam and were included in analyses with a value of 0 for chair stands per second. There were 25 participants with missing data for the chair stands exam who were excluded from analyses.

Dual x-ray absorptiometry

Whole body dual x-ray absorptiometry (DXA) scans (Hologic 4500A scanners, Hologic, Waltham, MA) were completed to measure lean and fat mass of the upper and lower extremities and percent body fat. The average of the left and right arms was used for arm lean and fat mass, and the average of the left and right legs was used for leg lean and fat mass. A number of participants were missing DXA-based measures: 79 participants were missing leg lean or fat mass; 21 were missing arm lean or fat mass; and 113 participants were missing total body lean mass, total body fat mass, and total body percent fat measures.

Muscle density and thigh muscle CSA

Thigh muscle density and thigh muscle cross-sectional area (CSA) were assessed using computed tomography (CT). The density of the thigh muscle was calculated as the mean attenuation coefficient of muscle tissue in Hounsfield units (HU). A lower attenuation coefficient indicated decreased muscle density and increased muscle lipid content.²² CT scans, and thus muscle area and density measures, were not completed for 64 participants. The average of the left and right legs is reported for CSA and the muscle density measure.

Other measures

Height was measured using wall-mounted stadiometers, and weight was measured using balance beam scales; BMI was calculated as weight (kg)/height(m)². Self-rated health was categorized as excellent/very good/good vs. fair/poor. Education (less than high school, high school, or more than high school), smoking status (current/never/past) and alcohol intake (none, less than once/week, ≥ 1 /week) were by self-report. Total activity level was estimated from questionnaire data and expressed as a physical activity score in kilocalories per kilogram per week.^{12,23} Prevalent medical conditions were ascertained by a combination of self-report, clinic data and/or medication use. Medical conditions considered in this analysis included cerebrovascular disease, coronary heart disease, peripheral arterial disease, congestive heart failure, hypertension, hip/knee osteoarthritis, osteoporosis, pulmonary disease, and diabetes. Participants were classified as having no medical conditions, 1–2 medical conditions or 3 or more medical conditions. A total of 73 participants were missing data for at least one of these self report health habits or medical history measures.

Statistical analyses

Characteristics of participants included in the factor analysis are reported as mean $\pm$ SD or N (%) for men and women separately. The interrelationship of the strength, fat, lean, thigh muscle CSA, and physical function variables was first assessed by Pearson's correlation coefficients. Then, factor analysis was completed with the intention of reducing the number of original variables into a smaller number of individual components. Only participants with data for all of the measures were included in the factor analysis (N=1,263 women and 1,221 men). Principal components was first used to determine the number of uncorrelated factors using an eigenvalue threshold of >1 ; the components were then rotated using the varimax rotation to produce interpretable factors which are uncorrelated with each other. An eigenvalue threshold of 1 was used to ensure that the identified components explained at least as much of the variance in the data as any original, standardized variable; a total of 14 components were generated.

To guarantee that variables used for interpretation share at least 15% of the variance with the identified factor, only those variables with a factor loading on a summary factor of ≥ 0.40 were used for interpretation of the factor. Due to differences in body size, adiposity and risk of disability between the sexes, all analyses were stratified by sex. Sub-analyses were completed with the cohort further stratified by race; these race-stratified sub-analyses were similar to sex-stratified results, thus only the sex-stratified results are presented.

To describe the three factors identified in the analyses, each factor was divided into deciles. The standardized mean for each of the strength, performance, lean mass, fat mass, and thigh muscle CSA and density variables was then determined for each decile of each factor, and the results were reported graphically.

The association between the components identified in the factor analysis and risk of subsequent major disability was also assessed. Each factor represents a latent continuous variable, standardized to a z-score scale with a range of approximately -3.0 to 3.0 , which is

not correlated with the other factors. Each factor was included as an independent variable in a single Cox proportional hazards model for each sex, to test the association of each with incident disability. Two sets of models were run for each sex: one set of models were adjusted for age, race, and clinical center. The second set were multivariate models adjusted for age, race, clinical center, alcohol use (none, 1–7 drinks/week, ≥ 7 drinks/week), smoking status (current/never/past), physical activity level (kcal/kg/week), education (less than high school, high school, or more than high school), number of co-existing medical conditions (none, 1–2, or 3+) and self rated health (excellent/very good/good vs. fair/poor). Covariates selected for inclusion in the multivariate models were associated with most or all of the muscle, fat and function parameters, and development of major disability.

Results

The average age of men included in this analysis was 73.7 years, while average age of women was 73.4 years, and average BMI was higher for women (27.5 kg/m^2) than for men (27.3 kg/m^2). Other characteristics of the participants at the baseline exam, stratified by sex, are reported in Table 1.

The correlations between the measures of strength, physical performance, lean mass, thigh muscle CSA, adiposity, and muscle density are seen in Table 2. Correlations between these measures tended to be similar for men and women. Measures of lean mass, thigh muscle CSA, weight and strength were highly interrelated in both men and women, and the correlation coefficients were all statistically significant. In both sexes, modest to weak associations were seen between measures of lean mass or thigh muscle CSA and physical performance, and between the two measures of physical performance. No or weak correlations were observed between muscle density and thigh muscle CSA or lean mass; modest correlation between muscle density and physical performance was noted for both sexes. The various measures of adiposity were highly interrelated in both sexes. In women, but not in men, measures of adiposity were modestly correlated with walking speed.

The first stage of factor analysis, principal components, identified three factors with an eigenvalue >1 , out of a total of 14 factors generated. Factor loading values were assessed for both sexes and are displayed for men in Figure 1. A higher factor loading value indicates a stronger association between the individual component and the factor identified. Initially, all variables with a loading value of $\geq |0.40|$ were considered associated with that factor. In Figure 1, variables that loaded onto each factor are grouped by circles of similar shading. In both men and women, Factor 1 was characterized by measures of adiposity (percent body fat, total body fat, arm fat, leg fat, thigh muscle density) and body size (weight, total body lean). In women, leg lean mass also moderately loaded with Factor 1. Therefore, Factor 1 was interpreted primarily as an adiposity factor. For both sexes, Factor 2 was characterized by body size (weight, total body lean), lean mass and thigh muscle CSA (total body lean, leg lean, arm lean, thigh muscle CSA), and strength (grip, knee extension) variables. Thus, Factor 2 was interpreted as a strength/lean body size factor. Factor 3 was characterized by physical function (walking speed and chair stands). Therefore, Factor 3 was interpreted as a physical performance factor. If a more liberal factor loading threshold of $\geq |0.30|$ was used, a few additional variables would be considered for the factors. For Factor 1 (adiposity/body size factor), leg lean mass would be added as a component for men. For Factor 2 (strength/lean body size factor), leg fat would be considered a component for men, and total fat and arm fat would be considered a component for women. For Factor 3 (performance factor) knee strength would be considered a component for both men and women. In general, the use of the more liberal factor loading threshold of $\geq |0.30|$ does not change the primary definition of each factor. For men, eigenvalue for Factor 1 was 6.7; for Factor 2 was 2.7 and for Factor 3 was 1.4. For women, the eigenvalue for Factor 1 was 7.2; for Factor 2 was 2.1

and for Factor 3 was 1.3. In men, the percent of variance explained was 44.7% for Factor 1, 19.5% for Factor 2, and 9.9% for Factor 3; the three factors combined explained 77.1% of the variance in the data for men. In women, the percent of variance explained was 51.3% for Factor 1, 15.4% for Factor 2, and 9.0% for Factor 3; the three factors combined explained 75.7% of the variance in the data for women.

To enhance interpretation of the three main factors identified by the factor analysis, the standardized means of some of the 14 components included in the factor analyses are the plotted by decile of the factor score for each factor (Figure 2). For Factor 1, which has been interpreted as the adiposity factor, both men and women with the lowest scores for this factor have lower weight, lower percent body fat and higher thigh muscle density than those with the highest score of this factor. Also, the means for the knee extension strength, leg lean mass and walking speed do not vary greatly across the deciles for Factor 1 for either sex. Thus, higher scores on Factor 1 are indicative of greater adiposity. In contrast, for Factor 2, which has been interpreted as the strength/lean body size factor, the means of leg lean mass, weight, and knee extension strength vary widely across the deciles of the Factor 2 score for both sexes, while the means for percent fat, thigh muscle density, and walking speed do not vary much across the deciles of Factor 2 score. Thus, higher scores for Factor 2 are indicative of a larger lean body size and stronger phenotype. Finally, for Factor 3, which has been interpreted as the physical performance factor, the means of walking speed vary across the factor deciles for both men and women, while the means weight, percent fat, thigh muscle density and leg lean mass do not vary by decile of Factor 3. Knee extension strength varies somewhat across the deciles of Factor 3. Therefore, higher scores on Factor 3 reflect better performance on the physical function tests.

Over an average of 6.3 years ($SD \pm 2.6$, maximum 9 years) of follow-up, 308 men (25.2%) and 389 women (30.8%) developed major disability. Factor 1 (the adiposity/body size component) and Factor 3 (the physical performance component) were both related to risk of incident major disability (Table 3). A feature of factor analysis is that each of the factors generated are, by definition, uncorrelated with each other. Thus, for the primary analyses all three factors were analyzed in a single model. In multivariate models which included adjustment for covariates and all three factors simultaneously, each one unit increase in the factor score for Factor 1 was associated with an approximate 30% increase in the risk of disability in men and a 60% increase for women (HR for men: 1.30, 95% CI: 1.16, 1.46; HR for women: 1.61, 95% CI: 1.37, 1.88). Additionally, each one unit increase in the factor score for Factor 3 was associated with an approximate 49% reduction in the risk of disability for men (HR: 0.51, 95% CI: 0.52, 0.63) and a 35% reduction in the risk of disability for women. Factor 2 (the strength/lean body size component) was not associated with risk of disability in either men (HR per unit increase: 0.98, 95% CI: 0.87, 1.1) or women (HR per unit increase: 1.05, 95% CI: 0.94, 1.17) in multivariate models. In sub-analyses, when each factor was analyzed in a separate model, the results were unchanged (data not shown.)

Discussion

The first aim of this analysis was to determine how measures of lean mass, thigh muscle CSA, adiposity, strength, physical performance and muscle density co-segregated using factor analysis as a data reduction step. Contrary to our initial hypothesis, this process identified only three factors (not four) that explained approximately 76% of the variance in the data for both men and women. The factors identified were: Factor 1, a body size/adiposity component; Factor 2, a strength/lean body size component; and Factor 3, a physical function component. Factor analysis demonstrated that lean mass, thigh muscle CSA and strength are very highly interrelated and these variables could not be disentangled from one another. Scores for Factor 1 (adiposity/body size) or Factor 3 (physical

performance) were strongly and independently associated with risk of disability over more than six years of follow-up. However, scores for Factor 2 (indicating greater strength/larger lean body size) were not associated with disability risk. Despite differences in body size and risk of disability between men and women, the results of the factor analyses and subsequent associations with disability were similar for both sexes.

While previous cross-sectional and longitudinal reports have linked adiposity, lean mass, strength and physical performance with disability, none have rigorously evaluated all of these inter-related factors simultaneously.^{5–12,20,24–26} Traditional regression approaches, such as logistic or proportional hazards models, have limitations when analyzing correlated variables such as those included in the present report, specifically problems due to the collinearity of the variables. Through the use of factor analysis, our data confirms that adiposity and physical performance are linked to an increased risk of disability in both older men and women.^{1–3,12–14,27,28} Previous reports have conflicting data about the association between lean mass and disability: some reports demonstrate an association between decreased lean mass and disability risk^{5–7} and others show no association.^{8–10} Factor 2 (lean mass/strength factor) was not related to disability risk in these analyses. While measures of strength most strongly loaded with Factor 2, there was some weak loading by knee extension strength on Factor 3 (the physical performance factor). This implies that some small part of the association between physical performance and disability may be due to strength, possibly through intermediate pathways. The evidence presented in this paper suggests that interventions that specifically target adiposity, such as weight loss (and presumably current fat loss and increased muscle density) and those that specifically target improving physical performance (such as a program that aims to improve walking speed via a variety of mechanisms) may be more important in preventing disability than interventions that target lean mass and strength alone (such as simple resistance training), but this hypothesis could only be tested in randomized trials.

In a clinical setting, our results suggest that lean mass and weakness alone should not be used to assess risk of disability in patients. Other factors such as adiposity and physical performance should be evaluated instead of (or in addition to) measures of strength and lean mass, in order to best classify those at higher risk of developing disability.

These analyses were completed in a large, well-characterized cohort of older black and white men and women, and follow-up for disability is excellent as disability status has been assessed at least once after baseline for all participants (either directly or by report of a proxy identified by the participant). However, a number of limitations must be noted. Each factor is an algebraic abstraction which makes the interpretation of the factor scores difficult. Factor analysis should be viewed as a first step, and the results from this analysis could inform future research. For example, the results from this factor analysis, or others from more representative cohorts, could be used in the development of a risk model (such as the Gail risk model for breast cancer)²⁹ for disability-related outcomes. These results suggest that such a risk model would have at least two major components: one for physical function and one for adiposity. As factor analysis grouped many individual measures into only three underlying factors, such a risk model may include only one representative variable from each factor – perhaps BMI or weight for adiposity, for example. An additional limitation of our results is that the Health ABC population was free of disability at baseline; similar analyses in less healthy populations may result in different conclusions. Finally, our results do not clearly link various biological pathways with risk of disability.

In summary, strength, thigh muscle CSA, and lean mass are highly inter-related, clustering as a single component in factor analysis. Muscle density was more closely related to adiposity than to physical performance, thigh muscle CSA or strength. The adiposity and the

physical performance components, but not the strength/lean body size component, were risk factors for disability in healthy, older adults.

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Figure 1.

Factor loading values of individual variables from factor analysis for men in the Health, Aging and Body Composition Study.

Footnote: For each factor, variables with a factor loading value of $> |0.40|$ are listed as a component of that factor. A higher factor loading value indicates a stronger relationship between the individual component and the factor identified through factor analysis. Circles are proportional to the amount of variance explained by each factor, listed as percents on the figure. Two variables (weight and total lean mass) had factor loading values of $> |0.40|$ and are thus considered components of both factors. The eigenvalue for Factor 1 was 6.7; for Factor 2 was 2.7 and for Factor 3 was 1.4. Factor loading patterns were similar for women, except for leg lean mass which had a factor loading of 0.80 for Factor 2 and 0.47 for Factor 1, and was thus considered a component of both factors.

Figure 2. Standardized means for weight, percent body fat, thigh muscle density, leg lean mass, knee extension strength and walking speed by the three factors* identified from factor analysis in the Health ABC Study.

*Factor 1 has been interpreted as the adiposity/body size component; factor 2 as the strength/lean body size component; and factor 3 as the physical performance component.

Table 1 Characteristics [N (%) or mean $\pm$ SD] of the Health ABC men and women included in the factor analysis

	Women N=1,263	Men N=1,221	p-value
Age (years)	73.4 $\pm$ 2.8	73.7 $\pm$ 2.9	0.003
White race	701 (55.5)	784 (64.2)	<.001
Height (m)	1.60 $\pm$ 0.6	1.73 $\pm$ 0.6	<.001
Weight (kg)	70.0 $\pm$ 14.1	81.2 $\pm$ 13.0	<.001
Body mass index (kg/m ²)	27.5 $\pm$ 5.3	27.0 $\pm$ 3.9	0.248
Leg lean mass (kg)	6.6 $\pm$ 1.2	9.1 $\pm$ 1.4	<.001
Arm lean mass (kg)	2.2 $\pm$ 0.4	3.6 $\pm$ 0.6	<.001
Total lean mass (kg)	41.1 $\pm$ 6.1	57.0 $\pm$ 7.2	<.001
Leg fat mass (kg)	5.5 $\pm$ 1.8	3.8 $\pm$ 1.1	<.001
Arm fat mass (kg)	1.8 $\pm$ 0.7	1.5 $\pm$ 0.4	<.001
Total fat mass (kg)	28.9 $\pm$ 8.9	24.1 $\pm$ 7.1	<.001
Percent fat mass (%)	40.5 $\pm$ 5.6	29.2 $\pm$ 5	<.001
Thigh muscle area (cm ²)	185.3 $\pm$ 34.2	263.9 $\pm$ 44.4	<.001
Thigh muscle density (HU)	34.0 $\pm$ 6.8	37.4 $\pm$ 6.3	<.001
Grip strength (kg)	25.3 $\pm$ 6.3	41.0 $\pm$ 8.7	<.001
Knee strength (N-m)	82 $\pm$ 21.8	132.7 $\pm$ 34.7	<.001
6-meter walking speed (m/sec)	1.1 $\pm$ 0.2	1.2 $\pm$ 0.2	<.001
Chair stands per second	0.4 $\pm$ 0.1	0.4 $\pm$ 0.1	<.001
Number of medical conditions			
None	270 (21.8)	257 (21.3)	0.912
1–2 conditions	853 (68.9)	834 (69)	
3 or more conditions	115 (9.3)	117 (9.7)	
Education			
Less than high school	280 (22.2)	325 (26.7)	<.001
High school graduate	498 (39.6)	314 (25.8)	
More than high school	481 (38.2)	580 (47.6)	
Alcohol use			
None	696 (55.2)	509 (42.0)	<.001
<1 drink/week	289 (22.9)	233 (19.2)	
>1 drink/week	226 (17.9)	330 (27.3)	
Smoking status			
Never	717 (56.8)	364 (29.9)	<.001
Current	120 (9.5)	129 (10.6)	
Past	425 (33.7)	725 (59.5)	
Physical activity level (kcal/kg/wk)	84.6 $\pm$ 65.9	84.2 $\pm$ 70.3	0.164
Self-rated health: excellent to good	1089 (86.4)	1035 (84.8)	0.258

Table 2

lean mass, thigh muscle CSA, physical performance and strength among men (in gray) and women (not highlighted) in position Study

Arm lean mass	Total Body Lean	Thigh muscle CSA	Thigh muscle density	Grip strength	Knee strength	Walking speed	Chair stands	Arm fat mass	Leg fat mass	Total body fat mass	Percent fat mass	Weight
0.84**	0.94**	0.83**	-0.26**	0.41**	0.49**	0.02	-0.01	0.51**	0.57**	0.54**	0.16**	0.82**
	0.88**	0.76**	-0.16**	0.50**	0.46**	-0.04	-0.02	0.44**	0.44**	0.41**	0.04	0.71**
0.89**		0.79**	-0.28**	0.39**	0.47**	0.02	-0.01	0.58**	0.59**	0.61**	0.23**	0.89**
0.78**	0.79**		-0.17**	0.37**	0.54**	0.09*	0.09*	0.44**	0.42**	0.44**	0.13**	0.68**
-0.21**	-0.31**	-0.22**		0.05	0.04	0.17**	0.15**	-0.46**	-0.56**	-0.53**	-0.50**	-0.46**
0.43**	0.38**	0.30**	0.03		0.40**	0.11**	0.17**	0.08*	0.12**	0.05	-0.14**	0.24**
0.40**	0.42**	0.50**	0.05	0.38**		0.21**	0.26**	0.17**	0.17**	0.18**	-0.01	0.36**
-0.22**	-0.20**	-0.14**	0.24**	0.03	0.15**		0.38**	-0.05	-0.09*	-0.04	-0.05	-0.01
-0.12**	-0.14**	0.02	0.20**	0.08*	0.14**	0.34**		-0.11**	-0.13**	-0.08*	-0.09*	-0.05
0.60**	0.69**	0.51**	-0.41**	0.16**	0.22**	-0.23**	-0.16**		0.83**	0.92**	0.81**	0.83**
0.45**	0.63**	0.40**	-0.47**	0.18**	0.20**	-0.24**	-0.17**	0.75**		0.89**	0.77**	0.83**
0.57**	0.73**	0.53**	-0.50**	0.17**	0.24**	-0.25**	-0.18**	0.92**	0.88**		0.89**	0.90**
0.19**	0.34**	0.22**	-0.47**	0.01	0.07*	-0.19**	-0.14**	0.79**	0.76**	0.87**		0.63**
0.75**	0.90**	0.68**	-0.45**	0.26**	0.33**	-0.25**	-0.18**	0.89**	0.83**	0.95**	0.70**	

Hazard ratios and 95% CIs for risk of major disability for each one unit increase in the components* identified by factor analysis for men and women in the Health, Aging and Body Composition Study.

Table 3

	Men N=1,221 [†]			Women N=1263 [‡]		
	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Age, race, clinic adjusted [§]	1.32 (1.19, 1.47)	0.94 (0.84, 1.06)	0.49 (0.43, 0.55)	1.57 (1.35, 1.83)	1.01 (0.91, 1.13)	0.60 (0.54, 0.67)
Multivariate –adjusted ^{**}	1.30 (1.16, 1.46)	0.98 (0.87, 1.10)	0.51 (0.44, 0.58)	1.61 (1.37, 1.88)	1.05 (0.94, 1.17)	0.65 (0.58, 0.73)

*. Factor 1 has been interpreted as the adiposity/body size component; factor 2 as the lean mass/strength component; and factor 3 as the physical performance component.

[†] mv adjusted n=1189 due to missing data for some covariates

[‡] mv adjusted n=1228 due to missing data for some covariates

[§] The age, race and clinical adjusted model includes all three factors in a single model.

^{**} The multivariate models are adjusted for age, race, clinical center, alcohol use, education, self-rated health, number of medical conditions, smoking and exercise, and include all three factors in a single model.