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Body composition as a predictor of physical performance in older age: A ten-year follow-up of the Helsinki Birth Cohort Study

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ABSTRACT

Background: This study assessed how different measures of body composition predict physical performance ten years later among older adults.
Methods: The participants were 1076 men and women aged 57 to 70 years. Body mass index (BMI), waist circumference, and body composition (bioelectrical impedance analysis) were measured at baseline and physical performance (Senior Fitness Test) ten years later. Linear regression analyses were adjusted for age, education, smoking, duration of the follow-up and physical activity.
Results: Greater BMI, waist circumference, fat mass, and percent body fat were associated with poorer physical performance in both sexes (standardized regression coefficient [β] from −0.32 to −0.40, $p < 0.001$). Lean mass to BMI ratio was positively associated with later physical performance (β = 0.31 in men, β = 0.30 in women, $p < 0.001$). Fat-free mass index (lean mass/height^2) in both sexes and lean mass in women were negatively associated with later physical performance. Lean mass residual after accounting for the effect of height and fat mass was not associated with physical performance.
Conclusions: Among older adults, higher measures of adiposity predicted poorer physical performance ten years later whereas lean mass was associated with physical performance in a counterintuitive manner. The results can be used when appraising usefulness of body composition indicators for definition of sarcopenic obesity.

1. Introduction

It has been suggested that sarcopenic obesity is an important risk factor for morbidity and disability in older age (Prado, Wells, Smith, Stephan, & Siervo, 2012; Stenholm, Harris et al., 2008). Sarcopenia refers to loss of muscle mass and strength (Mclean & Kiel, 2015) and sarcopenic obesity to the coexistence of high adiposity and low muscle mass (Stenholm, Harris et al., 2008; Prado et al., 2012). Older age is a susceptible time for developing sarcopenic obesity as muscle mass typically decreases with age while fat mass increases. Sarcopenic obesity, however, still lacks a widely accepted definition (Batsis et al., 2013) as does its component, sarcopenia (Mclean & Kiel, 2015). Different measures have been suggested for determining sarcopenia such as appendicular skeletal muscle mass index (skeletal muscle mass of the limbs/height^2) (Cruz-Jentoft, Baeyens, Bauer, Boirie, & Cederholm, 2010; Studenski, Peters, Alley, Cawthon, & McLean, 2014), fat-free mass index (fat-free mass/height^2) (Janssen, Baumgartner, Ross, Rosenberg, & Roubenoff, 2004), lean mass to total mass ratio (Janssen, Heymsfield, & Ross, 2002), and appendicular lean mass to body mass index (BMI) ratio (Studenski et al., 2014). Sarcopenic obesity, in turn, has been defined using various combinations between the above mentioned sarcopenia measures and different measures of obesity, such as BMI and

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percentage body fat (Prado et al., 2012).

To be clinically meaningful, a measure should predict later outcome relevant for health or functioning. However, most of earlier studies examining the relationship between body composition and physical performance among older adults have been cross-sectional. Previous cross-sectional studies have reported that lean mass without adjustment for obesity is not associated with physical performance (Bijlsma, Meskers, van den Eshof, Westendorp, & Sipilä, 2014) or functional limitation (Batsis, Mackenzie, Lopez-Jimenez, & Bartels, 2015). Further, lean or fat-free mass adjusted for height has been found to correlate poorly with physical performance and functioning (Bijlsma et al., 2014; Matta, Mayo, Dionne, Gaudreau, & Fülöp, 2014; Newman, Kupelian, Visser, Simonsick, & Goodpaster, 2003). A longitudinal study reported that low appendicular lean mass adjusted for height predicted better functioning (Delmonico, Harris, Lee, Visser, & Nevitt, 2007), which is in contrast with the concept of sarcopenia. However, combined measures of lean mass and obesity, for example (appendicular) lean mass to BMI ratio (Batsis et al., 2015; Cawthon, Peters, Shardell, McLean, & Dam, 2014), percent lean mass (Bijlsma et al., 2014) or lean mass residual after accounting for fat mass (Delmonico et al., 2007), have been found to correlate positively with physical performance and functioning.

Only few studies have studied different measures related to sarcopenic obesity in a same study in a follow-up setting. Studying a variety of measures within the same study sample is important as estimates from different study samples cannot be directly compared to each other. Hence, it is not well known how different body composition measures related to sarcopenic obesity predict later objective measures relevant for functioning among older people and how these measures compare to each other. This information is needed when assessing the validity of measures in terms of sarcopenic obesity.

The aim of this study was to examine how different measures of body composition predict physical performance 10 years later among older adults. The ability of the body composition measures to predict later physical performance was tested separately for men and women.

2. Materials and methods

This study is part of the Helsinki Birth Cohort Study (HBCS) that includes 13345 individuals born in Helsinki between 1934 and 1944. In the year 2000 of those born in the Helsinki University Central Hospital (n = 8760), a random sample of 2902 individuals were invited to participate in a clinical examination conducted between the years 2001 and 2004 (Eriksson, Osmond, Kajantie, Forsén, & Barker, 2006). From those who participated (n = 2003), 1404 people who were alive and living within a 100 km distance from Helsinki were invited to participate in the second clinical examination in 2011–2013 (Perälä, von Bonsdorff, Männistö, Salonen, & Simonen, 2016). A total of 1094 participants attended and of these, 1076 had data on both physical performance and at least one of the body composition measures and were thus included in the analysis. Both among men and women, those who were included in the analysis were slightly younger, more educated, had lower percent body fat, and had better physical functioning than those excluded but they did not differ in the level of physical activity.

2.1. Body composition and anthropometry

Body composition was assessed by bioelectrical impedance analysis using the InBody 3.0 eight-polar tactile electrode system (Biospace Co, Ltd, Seoul, Korea) (Malavolti, Mussi, Poli, Fantuzzi, & Salvioli, 2003). The instrument estimates lean body mass and percentage body fat by segmental multi-frequency (5, 50, 250, and 500 kHz) analyses separately for trunk and each limb. The resistance measurements were made with the subject standing in light clothing on the 4-foot electrodes on the platform of the analyzer and gripping the two palm and thumb electrodes. Height was measured without shoes on to the nearest 0.1 cm and weight was measured in light indoor clothing to the nearest 0.1 kg. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. Waist circumference was measured midway between the lowest rib and the iliac crest. We used the following anthropometric/body composition variables as predictors in the analyses: BMI, waist circumference (cm), lean mass (kg), fat mass (kg), percent body fat (= fat mass/total body mass), lean mass to BMI ratio (= lean mass/BMI) (Cawthon et al., 2014), fat-free mass index (= lean mass/height^2) (Janssen et al., 2004), and lean mass residual (Newman et al., 2003). Lean mass residual was computed by regressing lean mass on height and fat mass i.e. it is the part of variation in lean mass not accounted for by height and fat mass (Delmonico et al., 2007). For the computation of lean mass residual, all available data were used (n = 1918), including those who had no follow-up data.

2.2. Physical performance

Physical performance was assessed by using the Senior Fitness Test battery (SFT) (Rikli & Jones, 2013a, 1999). The test battery has been validated against the level of independence in physical functioning (e.g. self-care, household chores and walking outdoors) (Rikli & Jones, 2013b). The tests have also been shown to discriminate across different age groups and between individuals with low and high physical activity (Rikli & Jones, 1999). We used a modified test battery consisting of five components of the SFT: number of full stands in 30 s with arms folded across chest to assess lower-body strength; number of bicep curls in 30 s while holding a hand weight (3 kg for men and 2 kg for women) to assess upper-body strength; chair sit and reach to assess the lower-body flexibility (from sitting position with leg extended at front of chair and hands reaching toward toes, number of cm (+ or −) from extended fingers to tip of toe); number of meters walked in 6 min to measure aerobic endurance; and back scratch to assess upper-body flexibility (with one hand reaching over shoulder and the other one up middle of back, distance (cm) between extended middle fingers (+ or −)). All measurements were performed by a team of trained research assistants. For each test, the scores of the participants were also classified with respect to percentile tables of normative data for each 5-year age group (Rikli & Jones, 2013a). A rating from 1 to 20 was given according to each five percentile range, with 1 being the worst performance (score below the fifth percentile), 2 the score from the 5th to the 9th percentile, and 20 the best performance (in or above the 95th percentile). Then we calculated an overall score, which was the sum of the normalized scores for the five SFT test components. The overall SFT score varied between 5 and 100.

2.3. Potential confounders

Date of birth was obtained from the hospital birth records. Completed years of education, smoking status, health characteristics, and medications used were assessed using questionnaires at the clinical examination in 2001–04. Of the diseases, cardio-vascular diseases, stroke, cancer and emphysema potentially affect both body composition and later physical performance and hence, these diseases were considered as potential confounders. Correspondingly, use of insulin, glucocorticoids or diuretics were considered as potential confounders. The participants also completed a validated Kuopio Ischemic Heart Disease Risk Factor Study (KIHD) questionnaire on 12-month leisure-time physical activity (Lakka and Salonen, 1992). Total leisure-time physical activity, including both non-conditioning (e.g. housework) and conditioning (e.g. resistance training) physical activity, in metabolic equivalent (MET) values per week was computed based on the questionnaire.

2.4. Data analysis

Initially, the relationships between body composition measures and