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Body composition in Swedish old people aged 65–99 years, living in residential care facilities

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ABSTRACT

It is important to evaluate body composition changes in subjects with an existing multi-system reduction in capacity, as a small decrease in fat-free mass (FFM) can cause serious impairments. The aim of the study was to describe body composition in old people living in institutions. Body composition data were collected within a study of 173 subjects with functional and cognitive impairment, aged 65–99 years, and living in residential care facilities. A bioelectrical impedance spectrometer (BIS) (Xitron Hydra 4200; 5–1000 kHz) was used to assess the amount of both FFM and fat mass (FM) which where adjusted for height. The Harpenden caliper and a tape measure were used to assess body fat, arm-muscle and arm-fat area (mm^2). A large proportion of the old and functionally impaired population was at risk of malnutrition or already malnourished (63.4% vs. 17.4%) according to Mini-Nutritional Assessment (MNA). Women had significantly lower fat-free mass index (FFMI) and higher FMI, inversely related to age, than men. Bioelectrical impedance spectroscopy and anthropometrical measurements correlated but on different levels. In addition the FM% differed between the two methods (46.3% vs. 33.4%).

1. Introduction

It is important to evaluate body composition changes as it has a strong impact on health and disease. The amount of muscle mass declines with age and after the age of 50, the process seems to accelerate (Lexell et al., 1988; Starling et al., 1999). Malnutrition, which contribute to loss of fat-free mass (FFM) affects the muscle function, exercise capacity, health status, and even mortality rates (Woo et al., 2001; Cesari et al., 2006; Hickson, 2006). Knowledge in distribution of body fat and muscle mass is particularly important to obtain in old people with a multi-system reduction in reserve capacity, as a small decrease in FFM, may lead to significant problems in daily life (Campbell and Buchner, 1997; Omran and Morley, 2000; Wirth et al., 2007).

Body composition has been described in healthy and physically active old subjects, in frail, elderly women living independently and in hospitalized patients up to the age of 98 years (Kyle et al., 2001b, 2003; Schutz et al., 2002). However, no study has been found, which assesses body composition in old people with multiple diagnoses, severe physical and cognitive impairment, living in residential care facilities.

Conventional measurements of body weight and body mass index (BMI) do not provide information about distribution of body compartments and are thus not appropriate for use in assessing levels of nutritional status (Guo et al., 1999). Weight stability could mask selective changes in FFM and fat mass (FM) in old subjects and it is, therefore, important to study the distribution of body composition at higher age (Gallagher et al., 2000). There are various methods for assessing FFM and FM. Traditional anthropometry has often been used in epidemiological studies, as it is easy to perform (Siri, 1956; Durnin and Womersley, 1973; Frisancho, 1981). Dual-energy X-ray absorptiometry (DEXA), hydrodensitometry, and whole-body potassium are accurate methods often referred to and used in other studies (Snead et al., 1993; Albanese et al., 2003). However, the expense of performing these techniques may limit their use, as the measurements requires cooperation of the individual, which may be complicated in an older population with severe physical and cognitive impairments (Durnin and Taylor, 1960; Jebb, 1995). Bioelectrical impedance spectroscopy (BIS) is a validated tool for monitoring FFM and FM, and provides valuable information about body composition (Earthman et al., 2000) and is in addition portable, easy to use and safe (Kyle et al., 2002).

The aim of this study is thus to describe body composition in old people living in institutions, using BIS and traditional anthropometry.

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2. Subjects and methods

The present descriptive study originated from a randomized, controlled intervention study, of 191 old subjects, the "Frail Old People Activity and Nutrition Study in Umeå" (the FOPANU study) (Rosendahl et al., 2006). The baseline data obtained were used to evaluate body composition. The study subjects lived in nine residential care facilities in Umeå, Northern Sweden. The facilities comprised private flats with access to dining rooms, alarms, nursing and care. Four facilities also comprised units with private rooms and staff on hand, for people with dementia. The inclusion criteria were being dependent on assistance from a person in one or more personal activities of daily living (ADL) according to the Katz Index (Katz et al., 1963); ability to stand up from a chair with armrests, with the help of no more than one person; and a score of 10 or more on a Mini-Mental State Examination (MMSE) (Folstein et al., 1975). The residents responding to the inclusion criteria, or their relatives in cases of a cognitive impairment (Olde Rikkert et al., 1997a), gave their informed oral consent.

No BIS and anthropometry measurements were performed, if the subjects had a pacemaker implemented or suffered from right-sided hemiplegics. Values influenced by technical errors, disturbance from artificial joints, plates, or other types of metal objects in the body, were excluded. After these exclusions (n = 18), the 173 subjects who remained were included in the study.

The study was approved by the Ethics Committee of the Medical Faculty of Umeå University (91/01).

2.1. Assessment of cognition and physical function

Body weight was measured with the subjects wearing light clothing, sitting on a chair scale, calibrated to the nearest 0.1 kg. Height was measured in the supine position in bed using a tape measure and recorded to the nearest 0.5 cm. BMI was calculated as the weight in kilograms divided by the square of the height in meters (kg/m^2). The ability of an individual to perform basic activities of daily living was measured using the Barthel Index (0–20) (Mahoney and Barthel, 1965; Wade, 1992), and no differences were revealed between women and men in ADL.

Cognitive function was assessed using the MMSE score $\leq$17 indicating severe cognitive impairment (Folstein et al., 1975; Tombaugh and McIntyre, 1992). Women had a slightly lower, but not significant, cognition score according to the MMSE than men. The Mini-Nutritional Assessment (MNA) was used to assess nutritional status. The test gives a maximum of 30 points. MNA scores <17 indicates malnutrition, 17–23.5 a risk for malnutrition and $\geq$24 points indicate an optimal nutritional status (Guigoz et al., 1996). Depressive symptoms were screened for, by using the Geriatric Depression Scale (GDS-15). GDS scores between 0 and 4 are considered normal, scores of 5–9 indicate mild depression and from 10 to 15 moderate to severe depression (Sheikh and Yesavage, 1986). Both dementia and depression were diagnosed using the DSM-IV-TR criteria (APA, 2000, 1994).

2.2. Anthropometric measurements

Waist circumference was measured with a tape measure midway between the lower rib margin (costal margin) and the superior anterior iliac spine (iliac crest) to the nearest 0.5 cm, in a standing position. Calf circumference was measured at the level of the largest circumference of the right calf, to the nearest 0.5 cm. Mid-arm circumference (MAC) was measured halfway between the acromion process of the scapula and the tip of the elbow on the right arm, using a tape measure, to the nearest 0.5 cm (Frisancho, 1984). Skinfold thickness (ST) was measured at four sites on the right side of the upper part of the body to the nearest 0.2 mm using a Harpenden skinfold calliper (John Bull British Indicators Ltd., UK). Two trained dieticians carried out all the measurements. Body density was calculated (Durnin and Womersley, 1973) and adjusted for age and sex by the logarithm of the sum of the four skinfold measurement (ST = triceps, biceps, subscapular, suprailiac). Fat mass percent (FM%) was calculated by applying a frequently used formulae (Siri, 1956):

$$\text{Women}: \text{Bd} = 1.1339 - 0.0645 \log_{10} \sum_{i=1}^{i=4} \text{ST}_i$$

$$\text{Men}: \text{Bd} = 1.1715 - 0.0779 \log_{10} \sum_{i=1}^{i=4} \text{ST}_i$$

$$\text{FM}\% = \frac{4.95}{\text{Bd}} - 4.5 \times 100$$

The upper-arm area (AA), arm-muscle area (AMA), and arm-fat area (AFA) was derived from the measurements of MAC and triceps skinfold (T) in millimeters using the following formulae (Frisancho, 1981):

$$\text{AA}\,(\text{mm}^2) = \frac{\pi}{4} \times d_1^2$$

$$\text{where } d_1 = \frac{\text{MAC}}{\pi}$$

$$\text{AMA}\,(\text{mm}^2) = \frac{(\text{MAC} - \pi T)^2}{4\pi}$$

$$\text{AFA}\,(\text{mm}^2) = \text{AA} - \text{AMA}$$

2.3. Bioelectrical impedance spectroscopy

We used a multifrequency spectrum analyzer with Cole-Cole modeling software (Hydra ECF/ICF; Hydra model 4200 Xitron Technologies, San Diego, CA) to measure whole-body BIS. The volume of extracellular (ECW) and intracellular water (ICW) was measured, by resistance and reactance generated from equations, following the Hanai mixture theory (Hanai, 1968). This theory is essentially based on the body's ability to function as a conductive medium of water, electrolytes, and lean tissue. The measurements were performed with 50-programmed frequencies, ranging from 5 kHz to 1 MHz. Body weight in kilograms, height in centimeters, and sex were entered into the BIS program according to the operating manual. After cleaning the skin with alcohol, two pairs of electrodes, ideal for use on old people with sensitive skin, were applied, on the hand/wrist and foot/ankle on the right side of the body. Cables with clips were connected to the electrodes. The measurements were taken while the subject was in a supine position, with arms resting slightly away from the trunk and the legs apart. The computer program "Hydra" calculated FFM from total body water, assuming that FFM contains 73% of total body water. FM was calculated as the difference between body weight (kg) and FFM (kg). To circumvent factors that limit the possibility of assessing nutritional status we adjusted for height to obtain fat-free mass index (FFMI) and fat mass index (FMI) (kg/m^2).

2.4. Statistical methods

The statistical program SPSS Version 13 (2006) software package for MS Windows was used in all calculations. Data analysis involved anthropometric measurements of women and men stratified for sex, age, expressed as means, with 95% confidence intervals (95% CI) and range. Two-sided t-test with p-values < 0.05 were considered statistically significant. Conventional multiple linear regression was used to analyze the specific body-composition measurements, anthropometric data and MNA, according to age and sex.