Prediction of appendicular skeletal muscle mass of older women using anthropometry-based equations

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Abstract

We evaluated the accuracy of two anthropometry-based equations, initially developed for middle-aged women for estimating appendicular skeletal muscle mass (ASMM), when applied to a group of older women. Weight (kg), height (m) and triceps skinfold thickness (TrSFT, mm) of 94 randomly selected community-dwelling older women, aged 65-86 years were studied. The equations [ASMM1=5.366+0.255(Weight)-0.064 (Age)-0.078 (TrSFT) and ASMM2=0.204(Weight) +8.802(Height)-0.045 (Age)-7.405] were cross-validated using the ASMM measured by dual energy x-ray absorptiometry ($ASMM_{DXA}$) as the reference standard. The concordance between $ASMM_{DXA}$ and ASMM estimated by the two equations were, ASMM1=R^2:0.93, SEE: 0.51kg and ASMM2=R^2:0.94, SEE: 0.48kg, respectively. Mean ASMM estimated by equations were not significantly different from mean $ASMM_{DXA}$. We conclude that the two equations examined in this study estimate the ASMM of older women with high accuracy.

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Background

In Sri Lanka the proportion of people over 60 years has increased from 5.3% in 1953 to 10.8% in 2003 and it is predicted to reach 25% by 2030 [1]. The expansion of this segment of the population will lead to a higher prevalence of non-communicable diseases and age-related degenerative diseases in the community.

Sarcopenia is a syndrome particularly seen among older adults, characterized by low muscle mass, muscle strength and function [2]. Sarcopenia leads to disability, recurrent falls, impaired quality of life, higher mortality and an increased health care burden [2].

The appendicular skeletal muscle mass (ASMM) which is a measure of muscle content is an essential criterion for the diagnosis of sarcopenia and accurate measurement of ASMM requires sophisticated techniques such as dual energy X ray absorptiometry (DXA), MRI and quantitative CT. Estimation of ASMM using anthropometric indices has been recommended to overcome the restricted availability of these technologies [2].

Anthropometry-based equations to estimate the ASMM of middle-aged women in Sri Lanka have been validated and published earlier [3]. The ability of these equations to estimate ASMM in older women, however, has not been evaluated. ASMM in older adults is closely related to ambulation, mobility, functional independence and the performance of daily activities. Hence, the maintenance of optimum ASMM and its functions in old age is paramount to preserve mobility and functional independence. The availability of technologies such as quantitative MRI, CT and DXA is restricted and clinicians should have a practical yet accurate method of estimating ASMM in clinical set ups. Evaluating the validity of anthropometry-based equations in estimating ASMM would provide a cost-effective simple strategy to screen the older women for sarcopenia and it will enhance preventive and rehabilitative care approaches in this group of patients.

In this study, we evaluated the validity of two anthropometry-based equations developed for middle-aged women in Sri Lanka, to estimate the ASMM in older women.

Methods

The study was approved by the Ethics Review Committee of the Faculty of Medicine, University of Ruhuna. Apparently healthy, randomly selected women (n=94), aged 65-86 years who participated for a community-

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based cross-sectional study conducted in Bope-Poddala Medical Officer of Health area in Galle District were taken for this analysis. All subjects were long-term residents of Galle district and the study area has socioeconomic indices such as poverty, mortality, literacy, life expectancy at birth and ethnic composition comparable to the entire country (www.statistics.gov.lk). Subjects with chronic diseases and on medications which could affect muscle metabolism, and those on supervised dietary or exercise programs were excluded.

The ASMM measured by (DXA) (Hologic Inc, USA) was considered the reference standard for validation ($ASMM_{DXA}$). Body weight (kg) and height (m) were measured to the nearest 0.1kg and 1cm, respectively using a stadiometer (NAGATA, Tainan, Taiwan) and triceps skinfold thickness (TrSFT, mm) was measured to the nearest 2mm using a skinfold caliper (Holtan Ltd, UK) [4]. All measurements were made by one investigator to minimize measurement errors.

The equations considered for cross-validation were as follows [3].

ASMM1 = 5.366+0.255 (Weight)-0.064 (Age)-0.078 (TrSFT)

ASMM2=0.204 (Weight)+8.802 (Height)-0.045 (Age)-7.405

These equations were considered accurate if the coefficient of determination was (R^2) >0.7 and standard error of estimate (SEE) was <3.5kg [5]. The equations were further tested for repeatability with Bland and Altman plots [6].

Results

Mean (SD) age of the study group was 66.4(4.6) years. Basic characteristics of measured variables are shown in the Table 1.

Table 1. Basic characteristics of measured variables

Characteristic	*Mean (SD)*
Height (m)	1.4 (0.05)
Weight (Kg)	54.3 (8.7)
TrSFT (mm)	15.8 (4.4)
ASMMDXA (Kg)	13.7 (2.0)

TrSFT = Triceps skinfold thickness, ASMMDXA = Appendicular skeletal muscle mass measured with DXA

Mean (SD) $ASMM_{DXA}$ and ASMM estimated by the two equations were, $ASMM_{DXA}$= 13.79(2.01), ASMM1=13.83(2.07) and ASMM2=13.78(2.03) Kg, respectively. Mean difference between ASMMDXA and ASMM1= -0.04 (range -0.14 to 0.06Kg, p=0.45) and ASMM2=0.01, (range -0.08 to 0.11Kg, p=0.85). Correlation, R_2 and SEE of ASMM1 were r: 0.96, R^2: 0.93, SEE: 0.51kg and for ASMM2 r: 0.97, R^2:0.94, SEE: 0.48kg.

Bland-Altman plots revealed satisfactory measurement agreement of the ASMMDXA and ASMM estimated by the two equations where more than 95% of values were within the limits of agreement (±1.96 SD of the mean difference) (Figure 1).

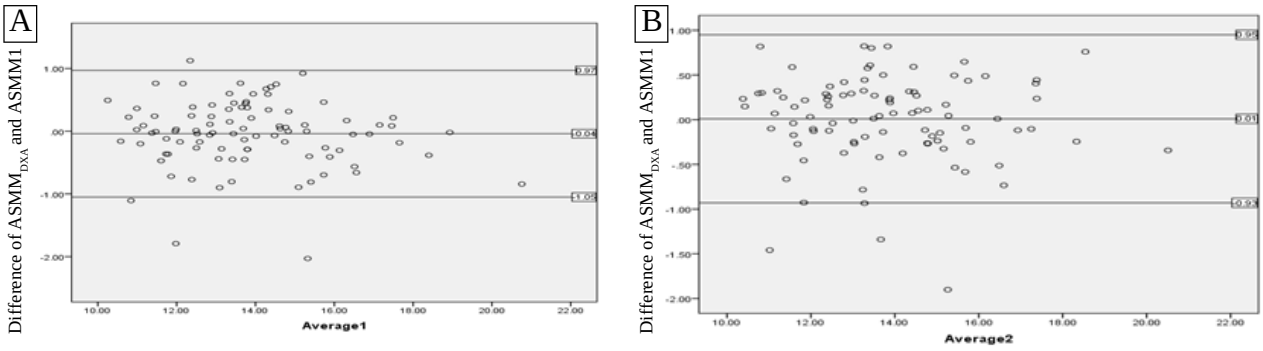

Figure 1. **Agreement between ASMM estimated with equations and ASMM measured with DXA ($ASMM_{DXA}$) (n=94).**

Discussion

We found the two anthropometry-based equations used in this study to be accurate when compared with DXA in estimating ASMM in older women. Hence these equations can be recommended as valid alternatives to DXA for the estimation of ASMM in women aged >60 years in Sri Lanka. Our findings are concordant with observations made by other researchers previously [7-10]. Apart from height and weight, some have used other anthropometric indices such as waist and arm circumferences.

The equations based on simple measurements, however, are suitable for busy and resource limited clinical set ups. This will help both integrating muscle mass in clinical evaluations of patients and accumulation of clinical data in this field of medicine.

Authors' contributions

All authors involved in conception of the study and design of the work, NR involved in data analysis and initial drafting of report, HR involved in data collection, SL involved in interpretation of analyzed data, critically reviewing of the report for important intellectual content. All authors read and approved the final version of the manuscript.

Conflicts of Interest

There are no conflicts of interest.

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Abbreviations

ASMM - Appendicular Skeletal Muscle Mass

TrSF - Triceps skinfold

DXA - Dual Energy X ray Absorptiometry

$ASMM_{DXA}$ - Appendicular Skeletal Muscle Mass measured by DXA

SEE - Standard Error of Estimate

R_2 - Coefficient of determination

SD - Standard deviation

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