

Clinical Validation of Calf Circumference with DEXA Scans as a Measure of Muscle Mass to Assess Sarcopenia in Community Settings in Indian Postmenopausal Women

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INTRODUCTION

Sarcopenia is conceptualized as a syndrome characterized by the gradual and generalized loss not only of muscle mass but also of muscle strength and function.^[1] The evaluation of muscle mass is a challenge in health services since its determination requires high-cost investigations such as magnetic resonance imaging and computed tomography. Anthropometric measures are recommended as an alternative for assessing muscle mass and early identification of sarcopenia in clinical practice. Among them, calf circumference (CC) has been used in recent studies with the objective of measuring muscle mass and estimating the prevalence of sarcopenia.^[2] The different cutoff points available in the literature vary from 31 to 35 cm, which hinders clinical judgment and therapeutic decisions in clinical practice.^[3] Considering the

ABSTRACT

Aims and Objective: To validate calf circumference as a reliable clinical tool for measuring muscle mass in postmenopausal women. **Materials and Methods:** A cross sectional study done at Ram Manohar Lohia Hospital, New Delhi from February 2023 to September 2023. Thirty postmenopausal women were enrolled for this study. Women with surgical menopause, premature ovarian failure, chronic debilitating illness and morbid obesity were excluded. In these women, muscle mass was measured using calf circumference. Also, Appendicular skeletal muscle index (ASMI), a measure of muscle mass was calculated using DEXA scan (Gold standard). The muscle mass was taken as a parameter by both methods to detect sarcopenia. The collected data was analysed and statistically evaluated to clinically validate calf circumference as a reliable tool for measuring muscle mass in Indian postmenopausal women. **Results:** In our study, the values at different cut offs of calf circumference was compared to ASMI scoring using gold standard investigation DEXA Scan. The better accuracy was found for the cut off point 32 cm of calf circumference with sensitivity of 100%, specificity of 60%, positive predictive value of 71.4%, negative predictive value of 100% and accuracy of 80%. The prevalence of sarcopenia was found to be 70%. **Conclusion:** Calf circumference can be used as reliable clinical tool to assess sarcopenia as a measure of muscle mass in Indian postmenopausal women.

KEYWORDS: Calf muscle circumference, DEXA scan, menopause, muscle mass, sarcopenia

possibility of applying CC as a low-cost and affordable care technology for the evaluation of muscle mass, especially in primary care services, the primary aim of this study was to validate CC as a mass evaluation technology. The secondary aim was to identify cutoff points in Indian postmenopausal women for decreased muscle mass.

MATERIALS AND METHODS

It was a cross-sectional study done at a tertiary-level teaching hospital in New Delhi from February 2023 to September 2023. Thirty postmenopausal

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women were enrolled in this study through the gynecological outpatient department. Women with surgical menopause, premature ovarian failure, chronic debilitating illness, and morbid obesity were excluded from the study. In this group of women, muscle mass was measured using CC with inelastic tape with the subject in the upright position, feet 20 cm apart, at the maximum circumference in the plane perpendicular to the longitudinal line of the calf.^[4] The measurement was performed in a standardized way, with three measurements to obtain the average of three measurements, using inelastic tape for all circumferences. The cutoff point for low muscle mass was taken as <33 cm, according to the Asian Working Group for Sarcopenia (AWGS) 2019.^[5]

Appendicular skeletal muscle index (ASMI), a measure of muscle mass, was calculated using DEXA scan (gold standard) in the same group. The muscular mass was obtained by means of DEXA, using Discovery Wi (S/N 84571) model, software version 13.3.0.1, and NHANES BCA calibration. Muscle mass was defined by the appendicular skeletal muscle mass (ASMM), which is estimated by the sum of the fat-free mass of the arms and legs. The decrease in muscle mass was defined by the appendicular skeletal muscle index (ASMI), the ratio between MMA and height squared.^[3,6] The cutoff point for low muscle mass was 5.4 kg/m² in women,^[1,6] according to AWGS 2019. The muscle mass was taken as a parameter by both methods individually to assess sarcopenia, according to AWGS 2019 consensus.^[5]

Statistical analysis

The data were analyzed in the software IBM SPSS (SPSS Inc., IBM Corporation, NY, USA) Statistics Version 2. The descriptive characteristics of the sample were expressed as means and standard deviation, and the mean differences were analyzed by means of the *t*-test at a significance level of 5%. To analyze the correlation between anthropometric variables and ASMI, the Pearson correlation was used, considering a strong correlation $r > 0.70$. The receiver operating characteristic (ROC) curve was used to analyze the sensitivity and specificity variation of different CC values in relation to the low muscle mass diagnostic criteria by DEXA. The total area under the ROC curve and 95% confidence interval for CC were identified according to the criterion of low muscle mass. Subsequently, the cutoff points for CC were identified, with respective values and confidence intervals of sensitivity, specificity, and accuracy. The values indicated through the ROC curve are cutoff points that should promote a more adequate balance between sensitivity and specificity.

OBSERVATION AND RESULTS

In our study ($n = 30$), values at different cutoffs of CC were compared to ASMI scoring using gold standard DEXA scan.

The cutoff point of 32 cm shows good accuracy of 80%, along with sensitivity of 100%, specificity of 60%, positive predictive value (PPV) of 71.4%, and negative predictive value (NPV) of 100%.

The prevalence of sarcopenia was found to be 21/30 (70%).

The values at different cutoffs of CC [Table 1] when compared to ASMI scoring can be explained as follows: considering a cutoff point of <30 cm CC, the prevalence of sarcopenia was observed to be 36.7%, sensitivity as 60%, specificity as 86.6%, PPV as 81.8%, and NPV as 68.4% with an accuracy of 76.6%. On increasing the cutoff value of CC to <32 cm, it was observed that the prevalence of sarcopenia was observed to be 70.0%, sensitivity increased to 100%, specificity reduced to 60.0%, PPV reduced to 71.4%, and NPV increased to 100% with an increased accuracy value of 88.0%. Finally, on considering the cutoff of the CC as <33 cm, it was observed that the prevalence of sarcopenia slightly increased to 73.3%. Sensitivity remained at 100%, specificity reduced further to 53.3%, PPV was reduced to 68.2%, and NPV remained at 100% with an accuracy slightly reduced to 87.5%.

30 postmenopausal women were enrolled in the study, out of which 15 (50%) were having decreased ASMI. 3/15 (20%) women were having decreased ASMI in the age group ≥ 70 years.

6/15 (40%) women were having decreased ASMI in the age group 60-69 years. 6/15 (40%) women were having decreased ASMI in the age group 50-59 years. No woman was found with decreased ASMI in the age group 40-49 years. It was seen that with increasing age, ASMI decreased. Age was found to be a significant variable for sarcopenia ($P = 0.041$). In our study, 2/15 (13.3%) women with decreased ASMI had a BMI <22.9 kg/m². 12/15 (80%) women with decreased ASMI had BMI in the range of 23-24.9 kg/m² and 1/15 (6.7%) woman with decreased ASMI had BMI ≥ 25 kg/m². In our study, 2/15 (13.3%) women with decreased ASMI had a duration of menopause of less than 10 years. 13/15 (86.7%) women with decreased ASMI had duration of menopause of ≥ 10 years [Table 2].

The number of postmenopausal women with decreased muscle mass calculated using CC and ASMI, when the cut-off of CC was taken as <30 cm, was 11 and 9 respectively. At this cut-off, the prevalence of women with decreased muscle mass was 11/30 (36.7%) [Figure 1].

Table 1: Prevalence of decreased muscle mass and predictive ability to identify muscle mass at different cutoffs of calf circumferences

Cutting point (cm)	Prevalence (n=30), n (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
<30	11 (36.7)	60	86.6	81.8	68.4	76.6
<32	21 (70.0)	100	60.0	71.4	100	88.0
<33	22 (73.3)	100	53.3	68.2	100	87.5

NPV: Negative predictive value, PPV: Positive predictive value

Table 2: Description of the sample and prevalence of decreased muscle mass measured by DEXA according to different variables

	Study population (%)		Decreased muscle mass (ASMI), (n=15; 50%), n (%)		Correlation	P
			<5.4	≥5.4		
Age group						
40–49	3 (10)	58.36±8.34	0	3 (20)	0	1
50–59	16 (53.3)	58.4±8.31	6 (40)	10 (66.7)	-0.381	0.145
60–69	6 (20)	57.62±7.00	6 (40)	0	-0.308	0.553
≥70	5 (16.6)	59.34±8.172	3 (20)	2 (13.3)	0.894	0.041 (significant)
BMI (kg/m ²)						
<22.9	3 (10)	23.6±2.82	2 (13.3)	1 (6.7)	-0.866	0.33
23–024.9	21 (70)	23.65±2.36	12 (80.0)	9 (60.0)	0.564	0.008 (significant)
≥25	6 (20)	25.71±2.90	1 (6.7)	5 (33.3)	-0.145	0.784
Duration of menopause (years)						
<10	8 (26.7)	5.89±6.88	2 (13.3)	12 (80.0)	-0.707	0.025 (significant)
≥10	22 (73.3)	16.31±6.35	13 (86.7)	3 (20.0)	-0.256	0.338

ASMI: Appendicular skeletal muscle index, BMI: Body mass index

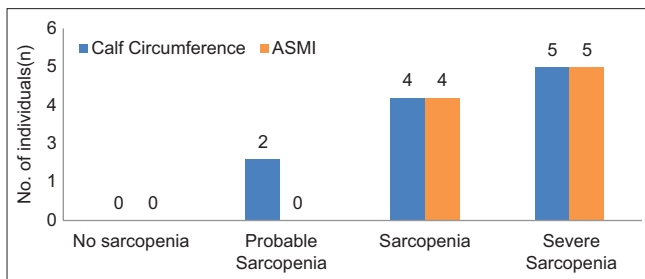


Figure 1: Subjects with prevalence of 36.7% at cutoff calf circumference <30 cm. ASMI: Appendicular skeletal muscle index

The number of postmenopausal women with decreased muscle mass calculated using CC and ASMI, when the cut-off of CC was taken as <32 cm, was 17 and 11 respectively. At this cut-off, the prevalence of women with decreased muscle mass was 21/30 (70%) [Figure 2].

The number of postmenopausal women with decreased muscle mass calculated using CC and ASMI, when the cut-off of CC was taken as <33 cm, was 22 and 15 respectively. At this cut-off, the prevalence of women with decreased muscle mass was 22/30 (73.3%) [Figure 3].

This concludes that calf circumference cut off points at 32 or 33 cm in Indian postmenopausal women provides

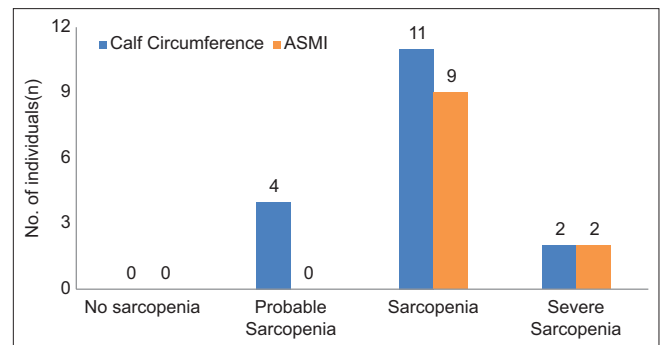


Figure 2: Subjects with prevalence of 70.0% at cutoff calf circumference <32 cm. ASMI: Appendicular skeletal muscle index

a good accuracy of decreased muscle mass in relation to ASMI when calculated using standard DEXA scans.

DISCUSSION

Human aging is accompanied by changes in body composition that include a progressive decline in muscle mass, termed sarcopenia in 1989 by Rosenberg.^[1] The prevalence of sarcopenia was 29% (11%–50%) using DEXA scan to estimate muscle mass, as recommended by the European Consensus of Sarcopenia.^[1] Despite its accuracy, its use is expensive in both primary and secondary care services. As a result, anthropometric measures are recommended as alternative measures

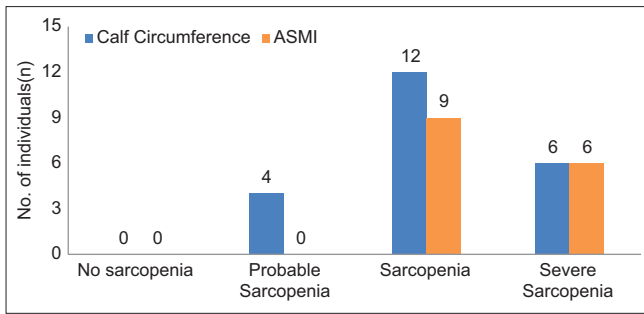


Figure 3: Distribution of cases according to grade of sarcopenia. ASMI: Appendicular skeletal muscle index

for assessing muscle mass and early identification of sarcopenia in primary health-care settings due to the low cost and ease of obtaining. Among them, CC has been used in recent studies with the objective of measuring muscle mass and estimating the prevalence of sarcopenia.^[2] The results demonstrate that CC has a good ability to predict muscle mass decrease. The different cutoff points available in the literature from 31–35 cm in women hinder clinical judgment and therapeutic decision-making.^[3] Considering the possibility of applying CC as a low-cost and affordable care technology for the evaluation of muscle mass, especially in primary care services, the overall objective of this study was to validate CC as a mass evaluation technology. As specific objectives, the study sought to verify the prevalence of decreased muscle mass according to DEXA and CC, as well as to analyze the predictive capacity of CC in identifying muscle mass and to identify cutoff points in Indian postmenopausal women.

Sarcopenia was assigned an individual International Statistical Classification of Diseases and Related Health Problems code (M62.84) in 2016, which stimulated diagnostic and therapeutic trials internationally. Japan published clinical practice guidelines for sarcopenia in 2018, which systematically reviewed the latest evidence and promoted awareness.^[7] The European Working Group on Sarcopenia in Older People (EWGSOP) issued an updated consensus in 2019 (EWGSOP2).^[8] In 2010, the EWGSOP proposed three diagnostic criteria for sarcopenia, based on muscle mass, muscle strength, and physical performance. In 2018, the EWGSOP revised its criteria and regarded muscle strength as the primary parameter in place of muscle mass. Using Western diagnosis, criteria for Asian people may not be accurate. For example, Asians are generally smaller, have more adipose tissue, and have a more physically active lifestyle. In 2014, AWGS proposed an algorithm for diagnosing sarcopenia based on Asian data, which was guided by EWGSOP but had different cutoffs for individual components. The AWGS consensus meeting held in Hong

Kong in May 2019 revised the diagnostic algorithm, protocols, and some criteria. As a result, anthropometric measures are recommended as alternative measures for assessing muscle mass and early identification of sarcopenia in clinical practice and primary health-care settings, due to low cost and ease of obtaining.^[9,10]

The first study to analyze the predictive capacity of CC was performed in French women and the suggested cutoff point was 31 cm, with sensitivity (44.3%) and specificity (91.4%).^[11] Although more recent studies have shown cutoff points with better sensitivity and specificity, a recent study was found in Mexico that assessed the prevalence of sarcopenia using the cutoff point of 31 cm of CC for estimation of decreased muscle mass, whose sensitivity in the present study (40.3%) and in the original study (44.3%) was low.

In the study with Mexican women, the prevalence of sarcopenia as measured by DEXA and CC was, respectively, 14.6% and 11%.^[2]

Recent studies have indicated that calf muscle circumference measured in a standing position has more accuracy than a sitting position.^[12] In our study, the cutoff point of 32 cm shows good accuracy of 80%, along with sensitivity of 100%, specificity of 60%, PPV of 71.4%, NPV of 100%, and prevalence of 70%.

In spite of the amplitude of the variations in these studies and in the present investigation, the proximity of the cutoff points found indicates that there is good accuracy in identifying the decreased muscle mass, except for the 30 cm point, which presented low sensitivity; the others have a good balance between sensitivity and specificity, with a higher specificity value.

Diagnostic tests with high specificity can decrease unnecessary interventions. On the other hand, the low sensitivity of the CC cutoff point may make it an inadequate tool for the screening of sarcopenia in elderly women.

The use of CC with a cutoff point of 32.0 cm or 33.0 cm implies a higher probability of correctly diagnosing postmenopausal Indian women with decreased muscle mass.

This study validated and identified calf circumferential cutoff points for decreased muscle mass using DEXA as a reference. In the studied population, the cutoff points of 32 cm in females presented a better predictive capacity for decreased muscle mass. In addition, the estimated prevalence of decreased muscle mass, according to these cutoff points, was similar to that identified by DEXA, which demonstrates the good accuracy of CC.

There is a paucity of literature carried out in Indian postmenopausal women on sarcopenia. This is a pilot study done to clinically validate CC with ASMI of DEXA scan as a measure of muscle mass to assess sarcopenia in community settings in Indian postmenopausal women. The limitation of this study is the small sample size. More studies using a larger sample size are required to have a cutoff for Indian women to apply CC as a tool for assessing muscle mass in sarcopenia.

CONCLUSION

CC can be used for the identification and follow-up of muscle mass reduction in postmenopausal women in community settings.

Ethical clearance

Ethical clearance was taken for the study from the institutional ethical committee through TP (MD/MS) 157/2022/IEC/ABVIMS/RMLH/1000.

Informed consent

Written informed consent was taken from all participants for the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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