

Can mid-upper arm circumference and calf circumference be the proxy measures to detect undernutrition among elderly? Findings of a community-based survey in rural Puducherry, India

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ABSTRACT

Introduction: Major proportion of the elderly with under nutrition is undetected in the community. One of the feasible ways to detect under nutrition among elderly would be screening in the field settings. In this study, we aimed to identify the utility of alternate anthropometric measures such as mid-upper arm circumference (MUAC), calf circumference, and skin fold thickness in identifying under nutrition among elderly. **Materials and Methods:** A community-based cross-sectional survey was done among elderly in one of the randomly selected subcenters. Anthropometric measures such as weight, arm span, MUAC, and triceps skinfold thickness were measured as per the standard measurement guidelines by a trained medical graduate. The elderly were identified as undernourished if body mass index (BMI) is $<18.5 \text{ kg/m}^2$. Utility of alternate anthropometric markers against BMI is represented by area under the curve (AUC) value from receiver operating characteristic curve and correlation coefficient (r). **Results:** Mean MUAC, calf circumference, and triceps skinfold thickness measured among 271 elderly were $25.6 \text{ cm} \pm 3.7 \text{ cm}$, $27.6 \text{ cm} \pm 3.7 \text{ cm}$, and $3.0 \text{ mm} \pm 1.3 \text{ mm}$, respectively. Among all three proxy anthropometric measures, MUAC had the highest AUC value (AUC = 0.88). Triceps skinfold thickness had the least AUC (AUC = 0.61). The correlation of anthropometric measurements such as MUAC, calf circumference, and triceps skinfold thickness with BMI was 0.74, -0.04, and 0.64, respectively. **Conclusion:** As MUAC and calf circumference are easy to measure and they are highly correlating with BMI, they can be used routinely by peripheral field workers to assess undernutrition in elderly during their regular house visits.

Keywords: Anthropometry, elderly, feasibility studies, malnutrition, receiver operating characteristic analysis

Introduction

Elderly population (60 years and above) keeps growing in the country. Globally, elderly contributes to 11% of total

population.^[1] In India, 8% of total population is contributed by elderly population amounting to 60.2 million as per the census 2011.^[2] As age advances, due to various degenerative changes, economic dependency and social isolation elderly are more prone for malnutrition, especially undernutrition or chronic energy

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deficiency. Several small studies have reported the prevalence of undernutrition among elderly ranging from 14% to 52%.^[3-5] However, major proportion of the elderly with undernutrition is undetected in the community.

Dysfunctions in physical mobility act as a physical barrier for elderly from reaching health facilities. One of the feasible ways to detect undernutrition among elderly would be screening in the field settings through community-based grass root level workers. Among the various nutritional assessment techniques, assessing undernutrition levels using body mass index (BMI) is the feasible option in resource-limited developing countries. Due to various skeletal changes occurring during the aging process, height cannot be used as reliable anthropometric measure to calculate BMI among elderly.^[6,7] During the house-to-house surveys, carrying a heavier weighing scale is practically a difficult task. Hence, an appropriate alternate anthropometric marker which is feasible and which can be easily carried and used in the field without compromising accuracy is in dire need.

Available literature shows high correlation among BMI and other anthropometric measures such as calf circumference, mid-upper arm circumference (MUAC), and skinfold thickness. However, these findings were reported by studies conducted in different age groups, especially among children and adolescents.^[8-10] There is a paucity of evidence about the existence of similar correlation between BMI and other anthropometric measures among elderly. Therefore, this study was planned to detect the usefulness of anthropometric measures such as MUAC, calf circumference, and triceps skinfold thickness in detecting undernutrition as compared to BMI among elderly in a field setting.

Materials and Methods

Ethics

The study protocol was reviewed and approved by Institute Ethics Committee of Indira Gandhi Medical College and Research Institute, Puducherry. The study was carried out in accordance with Declaration of Helsinki of Ethical Principles for Medical Research on human subjects. The eligible participants were informed about the study and written consent was obtained before the interview.

Study design

Selection and description of participants

A community-based cross-sectional study was done among elderly (aged 60 years and above) in one of the randomly selected subcenters under field practice area of Indira Gandhi Medical College and Research Institute, Pondicherry, from July to December 2013. House-to-house survey was conducted to identify elderly. All elderly were approached for the study.

Technical information

Anthropometric measures such as weight, arm span, MUAC, and triceps skinfold thickness were measured as per the standard

measurement guidelines.^[11] All the anthropometric measurements were taken by a trained medical graduate. Before testing in the field, all the instruments were calibrated by experts among five nondiseased individuals. Skinfold thickness which was measured using Harpenden caliper was calibrated to the accuracy of ± 1 mm. Weight and arm span were measured twice and average was considered for analysis. For mid-arm circumference, triceps skinfold thickness, and calf circumference, average of left and right side measurements was considered for analysis. Elderly were identified as undernourished if BMI is <18.5 kg/m².

Statistics

Data were entered in StataCorp. 2009. Stata Statistical Software: Release 11. College Station, TX: StataCorp LP. for further analysis. Correlation of BMI with other anthropometric measures is represented by scatter diagram and correlation coefficient (r) value. Utility of alternate anthropometric markers against BMI is represented by area under the curve (AUC) value from receiver operating characteristic curve. BMI calculated using weight and arm span was considered as the gold standard for this analysis. Sensitivity and specificity of these markers at specific cutoffs were also expressed in percentages. Anthropometric measure which gives highest sensitivity at the same time maintaining the substantial specificity was considered as cutoff value.

Results

Of total 296 elderly in the study setting, 271 (92%) elderly participated in the study. Of 271, 105 were males and 166 were females, with mean (SD) age of 67.0 (6.3) years and 66.6 (5.9) years, respectively. Overall mean BMI observed among study participants was 21.7 ± 4.4 kg/m². Mean MUAC, calf circumference, and triceps skinfold thickness measured were 25.6 cm ± 3.7 cm, 27.6 cm ± 3.7 cm, 3.0 mm ± 1.3 mm, respectively.

AUC for anthropometric measures is shown in Figure 1. Among the all three proxy anthropometric measures, MUAC

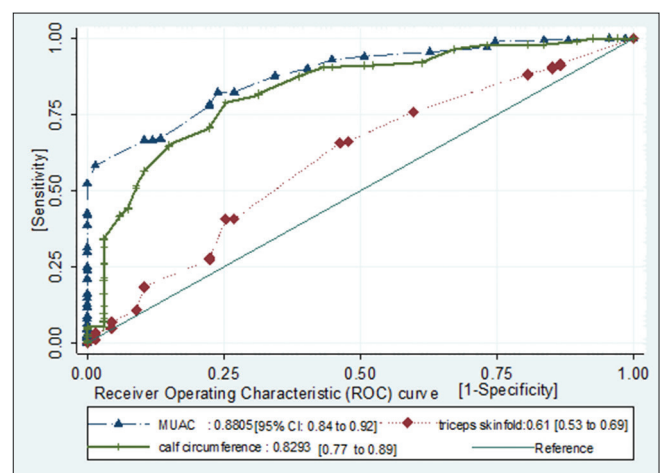


Figure 1: Comparison of diagnostic utility using area under the curve by various anthropometric measures in an elderly population (aged 60 and above), Puducherry, India

had the highest AUC value (AUC = 0.88) and it was statistically significant (AUC 95% confidence interval: 0.84–0.92). Triceps skinfold thickness had least AUC among the three. At cutoff value of 24 cm, MUAC had sensitivity of 82% and specificity of 76%. Similarly, at cutoff of 26.5 cm, calf circumference had sensitivity of 78.9% and specificity of 74.6%. At cutoff of 3 cm, triceps skinfold had sensitivity of 65.4% and specificity of 54.6% [Table 1].

The correlation of anthropometric measurements such as MUAC, calf circumference, and triceps skinfold thickness with BMI was 0.74, -0.04, and 0.64, respectively [Figure 2]. MUAC and calf circumference also had statistically significant high correlation between them ($r = 0.70$).

Discussion

Undernourished elderly are more vulnerable to suffer from respiratory disease, poor quality of life, and all-cause mortality.^[12-14] Economic dependency, lack of family support, and physical changes make elderly people vulnerable to suffer from undernutrition. Further, problems related to chewing and deglutition are considered to be the normal phenomena of geriatric life. Due to the poor health-seeking behavior and social neglect, identification of undernutrition among elderly is largely overlooked. Recognizing the burden of undernutrition among elderly needs sustainable, feasible tools for community-based screening.

Although Mini Nutritional Assessment scale is considered to be the most appropriate one, it needs more time for assessment. The current practice of diagnosing undernutrition with BMI needs accurate measurement of weight and height. Accuracy in anthropometric measurements mainly depends on using standard scales and frequent calibration. Moreover, various skeletal changes occur during aging process precludes usage of height in BMI derivation. To overcome this, mid-arm span was suggested as proxy measure for height. However, arm span needs more cooperations

in a standing posture from the participating elderly. Hence, instead of these anthropometric measures, applications of alternate simple techniques to measure anthropometrics are in need.

To provide targeted nutritional intervention among elderly, the primary requisite would be able to detect undernourished elderly using feasible and easy to use field techniques.

In this study, usage of MUAC, calf circumference, and triceps skinfold thickness was explored against BMI in detecting undernutrition. Among the various proxy anthropometric markers studied, MUAC and calf circumference had high utility in detecting undernutrition among elderly (AUC 0.88, 0.83, respectively). Triceps had AUC just above the worthless diagnostic test. Correlation among BMI and other anthropometric measures also conveyed the same results. Among all three alternate anthropometric markers, MUAC and calf circumference had significant positive high correlation (BMI vs. MUAC: $R = 0.74$, BMI vs. calf circumference: $R = 0.70$, BMI vs. triceps skinfold thickness: $R = -0.04$) but not the triceps. Similar correlation of MUAC with BMI was observed even from studies conducted among adolescents ($r = 0.84-0.88$).^[8-10] Furthermore, a study from rural Haryana reported high correlation ($r = 0.88$) of MUAC with BMI among elderly. The same study showed a least correlation between BMI and triceps skinfold thickness ($r = 0.59$) as reported in our study. This study from Haryana had also reported that the correlation will remain the same irrespective of gender. Similar to this current study, Haryana study had reported 26 cm and 29.6 cm as cutoff value to detect undernutrition with MUAC and calf circumference, respectively.^[3]

Strengths

This study conducted in a community-based setting demonstrates the feasibility of these alternate anthropometric tools usage in primary care setting. Since the entire measurement was taken by a single trained medical graduate, the interobserver variations were kept minimum.^[15]

Table 1: Diagnostic accuracy of various anthropometric measures against body mass index in an elderly population, Puducherry, India

Anthropometry measure	Sensitivity	Specificity	Correctly classified	LR+	LR-
Mid upper arm circumference (cms)					
24	82.3	76.1	80.8	3.45	0.23
24.3	78.4	77.6	78.2	3.50	0.28
Calf circumference (cms)					
26.5	78.9	74.6	77.9	3.11	0.28
26	81.4	68.7	78.6	2.61	0.26
Triceps skin fold thickness (mm)					
2.7	65.8	53.0	62.7	1.40	0.64
3	65.4	54.6	62.7	1.44	0.64

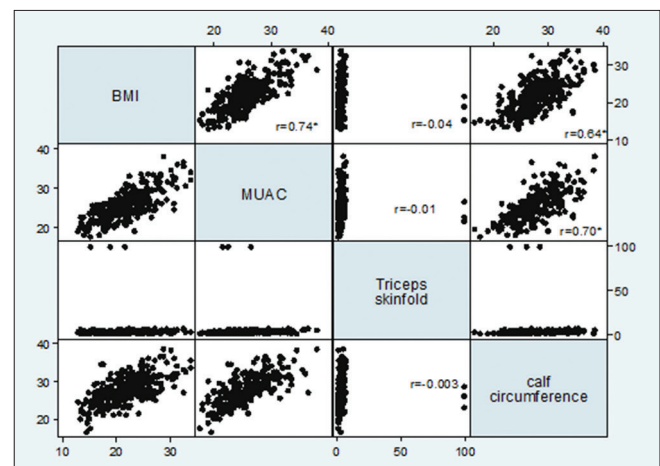


Figure 2: Scattergram representing the correlation between body mass index and other anthropometric measures

Limitations

However, this current study has a few limitations. The current study did not measure the actual nutrient intake. There is no standard reference population available and also the variation of cutoff values based on age and gender was not explored.

This study has few implications in the context of primary care setting. First, this study demonstrates that anthropometric measures such as MUAC and calf circumference are valid in comparison with BMI. Second, these alternate anthropometric measures make the assessment more user-friendly, fast, and easy to use in the field and involves weightless instrument. These markers can be measured even in lying down postures and hence can be used in bedridden patients. Thus, this study exhibits the feasibility of these alternate anthropometric measures in house-to-house community-based screening and primary care facilities. Third, MUAC and calf circumference were able to identify undernutrition in more than 80% of the affected undernourished elderly. As majority of elderly in rural India have lesser access to health facilities, sticking to facility-based screenings may not be adequate to reach all. Community-based screening could be an alternate option to reach the unreached. Fourth, this study proposes to sensitize the peripheral health workers to diagnose undernutrition among elderly using these proxy measures.

Conclusion

This study reports MUAC and calf circumference are valid anthropometric measures to diagnose undernutrition among elderly. Due to their easiness in measuring and weightless nature of the instrument used, they can be utilized for screening in primary care setting.

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Conflicts of interest

There are no conflicts of interest.

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