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ORIGINAL ARTICLE

EVALUATION OF MID UPPER ARM CIRCUMFERENCE AS A SCREENING TOOL FOR UNDERNUTRITION AMONG ADOLESCENT GIRLS IN TAMIL NADU, 2019

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ABSTRACT

INTRODUCTION : Body mass index (BMI) in anthropometry is a well-established indicator to assess the nutritional status. However the use of BMI as an indicator in the field level is limited as it involves multiple instruments. Mid-Upper Arm Circumference (MUAC) is used in severely malnourished children to identify with morbidity and those at risk of mortality. This study aims to assess the diagnostic accuracy of MUAC for undernutrition among adolescent girls compared with BMI as the gold standard.

METHODS : A community-based cross-sectional study was conducted among adolescent girls aged 10-19 years in Chengalpattu district, Tamil Nadu. Nutritional status was assessed based on comparison with standard cut-offs for BMI and MUAC. The diagnostic accuracy of MUAC compared with BMI was assessed using the proportion of true positives, false positives, true negatives, and false negatives using a 2 × 2 table. A correlation between BMI and MUAC was also expressed.

RESULTS : MUAC was 79.25% sensitive to detecting undernutrition and has 84.5% specificity to identifying those who were not undernourished. The correlation between BMI and MUAC was found to be 0.88.

CONCLUSION : MUAC can be used in settings where undernutrition prevalence is high.

KEYWORDS : Mid upper arm circumference, Body Mass Index, Screening, Undernutrition, Malnutrition

INTRODUCTION

Adolescents are individuals between 10 and 19 years of age.[1] Globally there are 1.2 billion adolescents. In India, adolescents contribute to 18% of the population.[2] UNICEF reports that half of India's adolescents (63 million girls and 81 million boys) are either thin, overweight obese or short. More girls suffer from shortness than boys.[3] To break India's intergenerational cycle of malnutrition, there is a need to focus on adolescent girls before they become mothers.[4]

Body mass index (BMI) in anthropometry is a well established indicator to assess the nutritional status5. However the use of BMI as an indicator in the field level has limitations as it involves multiple instruments like accurate weighing scales and stadiometers.[6]

Mid-upper arm circumference (MUAC) measures the arm muscle and fat area. MUAC is used in severely malnourished children to identify morbidity and those at risk of mortality. However, it is not used as an indicator for screening undernutrition among adolescents because of changes in the skeletal muscle and subcutaneous fat of this particular population.[6] Further, BMI can be affected by factors that mask overall body mass, like trunk edema due to protein-energy malnutrition, whereas MUAC is unaffected by this.[7] In resource-poor field settings, the availability of standardized well-calibrated equipment to measure weight and height and calculation of BMI or BAZ (BMI for age z-score) by field workers without field charts are difficult7. In order to use MUAC in the field, there is a need to assess its diagnostic accuracy for undernutrition compared with BMI. Hence we conducted this study to assess the diagnostic accuracy of MUAC for undernutrition among adolescent girls compared with BMI as the gold standard in two peripheral training centers of a tertiary care teaching hospital in Chengalpattu district, Tamil Nadu.

METHODS

Study design and setting: This was a community-based cross-sectional study conducted in two Field practice areas

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of the Rural and Urban Health Training Center of Karpaga Vinayaga Institute of Medical Sciences & Research Center, Chengalpattu, Tamil Nadu in April – October 2019.

Study population: Adolescent girls aged 10-19 years residing in the field practice areas of the two Peripheral Health Training Centers of Karpaga Vinayaga Institute of Medical Sciences & Research Center, Chengalpattu district, Tamil Nadu.

Sample size: In a study by Dasgupta A[8], the prevalence of undernutrition based on MUAC was 60%. With this prevalence and Absolute precision of 7%, the sample size derived was 196 adolescent girls.

Data collection: After obtaining ethical clearance from the ethical committee and taking permission from the concerned authorities from urban and rural field practice areas, house to house visit was made. After getting consent (from the mother if the girl is <12 years old or from the mother and the participant if she is >12 years old), anthropometric measurements were taken using standard techniques. Weight to the nearest 0.1 kg was recorded using a mechanical weighing scale with minimal clothing. Height was taken barefoot to the nearest 0.1 cm using a non-stretchable measuring tape. MUAC was measured in the right arm at the midpoint between the acromion and olecranon process to the nearest 0.1cm with a non-stretchable measuring tape. BMI was calculated using the formula weight (kg)/height (m2). Nutritional status was assessed based on comparison with standard cut-offs for BMI and MUAC. BMI z-score was categorized based on WHO - BMI cutoff for girls as normal (5th to 95th centile), underweight (<5th centile) and overweight/obese (>95th centile).[9] MUAC was compared with Center for Disease Control and Prevention (CDC) anthropometric reference data on MUAC for female children and adolescents as normal (5th to 95th centile), underweight (<5th centile) and overweight/obese (>95th centile).[10]

Statistical methods: Descriptive statistics were calculated as mean and standard deviation. Diagnostic accuracy of MUAC compared with BMI was assessed using sensitivity, specificity, negative predictive value, positive predictive value, positive and negative likelihood ratio, whose values were calculated using the proportion of true positives, false positives, true negatives, and false negatives using a 2 × 2 table. Correlation between BMI and MUAC was used to establish relationship between BMI and MUAC.

Ethical approval: Ethical clearance was obtained from the Institutional Ethics Committee of Karpaga Vinayaga Institute of Medical Sciences and Research Center.

RESULTS

This study was conducted among 196 adolescent girls. Among them, 14 girls were >95th centile according to BMI. Hence, only 182 adolescent girls whose BMI was <95th centile were included for analysis.

Table 1: Steps used for intervention development using the PRODCUES framework

Parameter	Mean	Standard deviation
BMI	24.19 kg/m^2	3.245
MUAC	18.51cm	3.12

Table 1 shows the mean BMI and MUAC of adolescent girls. The mean BMI was 24.19±3.24 kg/m2 and the mean MUAC was 18.51 ±3.12 cm.

Table 2: Distribution of study participants in relation to nutritional status based on BMI and MUAC, April – October 2019

Nutritional status	BMI	MUAC
Undernutrition	53 (29.1%)	62 (34.1%)
Normal	129 (70.9%)	120 (65.9%)
Total	182 (100%)	182 (100%)

According to BMI, 53 (29.1%) girls were undernourished and according to MUAC, 62 (34.1%) girls were undernourished (Table 2).

Table 3: Comparison of MUAC cut-off with BMI as the gold standard for undernutrition, April – October 2019

Undernutrition MUAC	Undernutrition BMI		Total
	Yes	No	
Yes	42 (TP)	20 (FP)	62 (TP+FP)
No	11 (FN)	109 (TN)	109 (FN+TN)
Total	53 (TP+FN)	129 (FP+TN)	182 (TP+FP+FN+TN)

*TP= True Positive, FP= False Positive, TN=True Negative, FN= False Negative

To compare the undernutrition status with MUAC and BMI, table 3 shows that 42 were true positive (undernourished in both BMI and MUAC), 109 were true negative (negative for undernourishment by BMI and MUAC), 20 were false positive (undernourished by MUAC, while normal by BMI) and 11 were false negative (normal by MUAC, while undernourished by BMI).

Table 4: Validity of MUAC as a screening tool

Measures	Results
Sensitivity	79.25%
Specificity	84.5%
Positive predictive value	67.74%
Negative predictive value	90.83%
Positive likelihood ratio	5.11
Negative likelihood ratio	0.25

Table 4 presents the results of using MUAC as a screening tool. MUAC was 79.25% sensitive to detect undernutrition, 84.5% specificity to identify those who were not undernourished. The yield of a test that is, positive predictive value was 67.74%. The predictive value of a negative test was 90.83%. The positive likelihood ratio was 5.11. The negative likelihood ratio was 0.25.

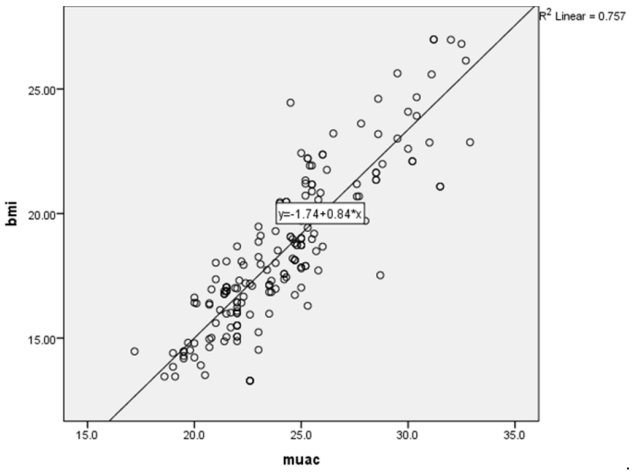

Figure 1: Scatter plot showing correlation between BMI and MUAC

Correlation between BMI and MUAC was found to be 0.88 (p <0.000), which signifies strong positive linear relationship. (Figure 1)

DISCUSSION

Since more than half of the adolescent population do not have normal nutritional status, a simple tool to measure their nutritional status in the field level is important. MUAC is one such tool to assess nutritional status. In this study, 34.1% girls were undernourished according to MUAC, while a study done among adolescent boys by Dasgupta A8, reported the prevalence of undernutrition by MUAC as 60.3%.

In the present study, regarding the use of MUAC as a screening tool, MUAC has 79.25% sensitivity to detect undernutrition, which is lower than Dasgupta A8, who reported 94.6% sensitivity. Among adolescents in Tanzania, the sensitivity of MUAC compared to BMI was 35% based on the Nutrition Assessment, Counseling, and Support (NACS) tool7. Positive predictive value was 67.74% in this study, while Dasgupta A8 reported as 93.5%. This difference could be because, positive predictive value is highly dependent on prevalence. The prevalence of undernutrition by BMI was 29.1% in this study, while it was 48% in the above study. The positive predictive value among adolescent girls in urban slums of Pune by Jayakumar A6 was 29.62%. The yield (positive predictive value) of a test that is number of cases detected is very important in low resource settings.

MUAC was positively correlated with BMI in this current study (r=0.88, p <0.001), which is similar to studies done by Dasgupta A8 (0.88, 0.001) and Sethi V11 (0.78) at Chhattisgarh and Odisha.

CONCLUSION

MUAC can be used in settings where the undernutrition prevalence is high. Given that MUAC and BMI are positively correlated, MUAC can be used in settings where BMI measurement is not feasible. This study used the MUAC cut-offs given by the Center for Disease Control (CDC) which is based on the United States population, which might underestimate undernutrition in Indian settings. Hence, standard MUAC cut offs for detecting undernutrition need to be developed for developing countries.

CONFLICT OF INTEREST: None

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