

Validating the MUAC (Mid-upper arm circumference) Cut-off for Detection of Severe Acute Malnutrition in Children Aged 6-59 Months in Rural Maharashtra

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Objective: To review the Mid-upper arm circumference (MUAC) cut-off currently being used to identify Severe Acute Malnutrition (SAM) as currently defined using Weight-for-Height. **Methods:** Cross-sectional study conducted in 24 villages of a Primary Health Centre in Wardha district of Maharashtra among 2650 children between the ages of 6 to 59 months. **Results:** For identifying SAM, sensitivity of MUAC was 23.5% and specificity was 99.7% for cut-off <11.5 cm. Using Youden index, best Mid-upper arm circumference cut-off point to identify SAM was <13 cm with sensitivity of 74.5% and specificity of 92.7%. Using Receiver operating characteristics curve, best MUAC cut-off point was 12.8 cm with 74.5% sensitivity and 92.7% specificity. Area under curve was 0.88 (95%CI: 0.85-0.91). **Conclusion:** The current MUAC cut-off of <11.5 cm for detecting SAM needs to be increased to ensure that children, who need referral for management of malnutrition, are not missed.

Keywords: Anthropometry, Diagnosis, Undernutrition, Wasting,

In India, around 6.4% children suffer from Severe Acute Malnutrition (SAM) [1,2]. World Health Organization (WHO) endorses Mid-upper arm circumference (MUAC) as a suitable tool for identifying SAM. MUAC as compared to the Weight-for-height (WFH)-based measurements confers several advantages, and many agencies are using MUAC as a basis for admitting children to feeding programs [3].

Usually WFH is used as the gold standard for identifying SAM. However, several studies reveal that MUAC could be even better than WFH for identifying SAM children at risk of death [4]. MUAC cut-off point 11.0 cm was related to mortality risk and therefore was considered for use in malnutrition screening and detection efforts among children between 6 and 59 months of age [4-8]. However, in 2009, WHO recommended to increase the cut-off point from 11.0 to 11.5 cm to define SAM with MUAC [9]. A multi-country study conducted in 2010 also supported the change in MUAC cut-off from <11.0 cm to <11.5 cm to identify children at greatest risk of death resulting from severe wasting [10].

As racial differences have been observed in body composition of children, there is need to validate these cut-offs separately for Indian children. Therefore, the present

study was undertaken to validate the cut-off of MUAC for identifying SAM as currently defined using WFH.

METHODS

The present study was conducted in 24 villages of Talegaon Primary Health Centre (PHC) of Wardha district in Maharashtra having a population of 44672. Study population was children between 6 to 59 months of age. Assuming sensitivity of MUAC with respect to WFH <3 SD as 50%, desired precision of 10% for 95% confidence, proportion of SAM children in age-group 6-59 months for Maharashtra as 4% and a non-response rate of 10%, the estimated sample size was 2650. Subjects were enrolled by house-to-house visit from April 2012 to March 2013 after obtaining written informed consent from the mother. Nutritional status of the children was assessed with the help of anthropometric measurements – weight, length/height and MUAC.

The study was initiated after approval from Institutional Ethics committee for human research at MGIMS, Sewagram. The primary caregivers of study subjects were counseled regarding child feeding. A list of children with SAM was provided to Anganwadi workers and health care providers for facilitating treatment.

Statistical analyses: Data was analyzed in STATA version 12, anthropometric analysis was done by using WHO's ANTHRO software. Each of the nutritional status indicators except for MUAC were expressed in standard deviation units (Z-scores) from the median of the reference population. Sensitivity and specificity of MUAC at particular cut-off with respect to WFH Z score <-3 SD was calculated. Youden index given by sensitivity + specificity -1 was calculated to know the accuracy of the cut-off points of MUAC for identifying SAM. Receiver operating characteristic (ROC) curve was also plotted to determine the cut-off point of MUAC for detecting SAM using R-software.

RESULTS

In the total 2650 study participants, 52% were males. The prevalence (95% CI) of severe underweight (weight for age <-3 SD), severe stunting (height for age <-3 SD) and severe wasting (weight for height<-3 SD) was 11.1% (9.9-12.3), 13.9% (12.7-15.3) and 8% (3.8-5.4), respectively (**Table I**). The best cut-off to diagnose SAM was found at MUAC <12.8 cm, where sensitivity was 74.1% and specificity was 93.2% and highest Youden index of 0.67 (**Table II**).

Fig. 1 shows receiver operating characteristic curve for severe acute malnutrition (W/H <-3SD) and MUAC (Area under curve 0.882; 95% CI: 0.85-0.91).

DISCUSSION

In the present study, prevalence of severe wasting (WFH) was found to be 8%. For diagnosing SAM at cut-off <11.5 cm, sensitivity was 23.5% while specificity was 99.7%. The best cut-off to diagnose SAM was found at cut-off point <12.8cm where sensitivity was 74.1% and specificity was 93.2% and highest Youden index of 0.67.

As data collection for the current study was done during home visits, we used Salter scale with 100 gm precision for measuring weight. We understand, for this

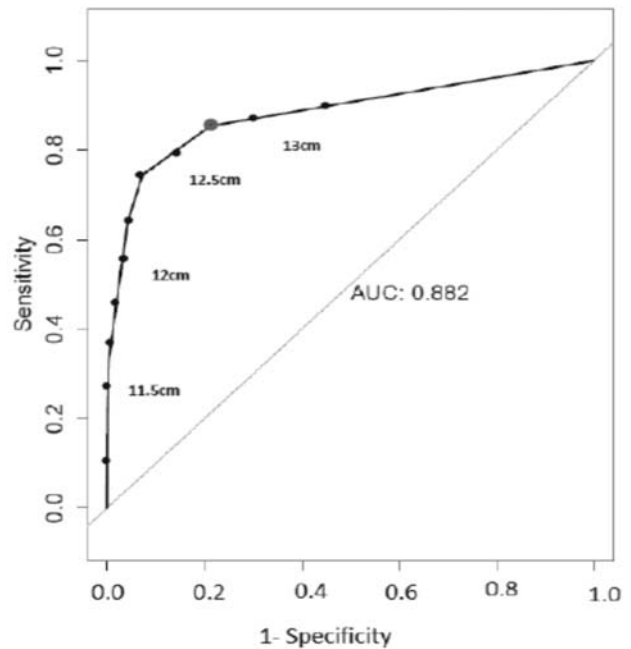


FIG. 1 ROC for Severe acute malnutrition (W/H <-3SD) and Mid-upper arm circumference.

kind of study, the precision of weight measurement is not optimum.

There was an increase in sensitivity for detecting SAM as the MUAC cut-off increased from 11.0 cm to 13.0 cm without much decline in specificity. Our findings are similar to that of Fernandez, *et al.* [10] in their multi-country study. Studies from Africa have reported a higher sensitivity for detecting SAM with cut-offs of 11.5 cm (65.1%) [5] when compared with the findings of the present study. The present study also reiterates the findings of studies from various regions of India [10-14], suggesting to increase the MUAC cut-offs for detecting SAM. It will help to identify more number of SAM children resulting from severe wasting.

TABLE I NUTRITIONAL STATUS BY AGE OF CHILDREN AGED 6-59 MONTHS (N=2650)

Age	Wasting(W/H), n=839		Underweight(W/A), n=1369		Stunting(H/A), n=1481	
	<-2SD	<-3SD	<-2SD	<-3SD	<-2SD	<-3SD
6-11(n=285)	69 (24.2%)	26 (9.1%)	74 (25.9%)	23 (8.0%)	55 (19.3%)	15 (5.26%)
12-23 (n=575)	130 (22.6%)	48 (8.4%)	205 (35.7%)	66 (11.5%)	274 (47.7%)	116 (20.2%)
24-35 (n=570)	138 (24.2%)	52 (9.1%)	244 (42.8%)	83 (14.6%)	255 (44.7%)	106 (18.6%)
36-47 (n=551)	112 (20.3%)	31 (5.6%)	240 (43.7%)	55 (9.9%)	246 (44.7%)	63 (11.4%)
48-59 (n=669)	178 (26.6%)	55 (8.2%)	312 (46.6%)	66 (9.9%)	281 (42%)	70 (10.5%)
Total (n=2650)	627 (23.7%)	212 (8%)	1075 (40.6%)	293 (11.1%)	1111 (41.9%)	370 (13.9%)

WHAT THIS STUDY ADDS?

- Sensitivity of Mid-upper arm circumference at currently recommended cut-off of <11.5 cm to detect severe acute malnutrition was low in a rural area of Maharashtra.

TABLE II SENSITIVITY AND SPECIFICITY OF MID-UPPER ARM CIRCUMFERENCE (MUAC) AS COMPARED TO WEIGHT-FOR-HEIGHT FOR DETECTING SEVERE ACUTE MALNUTRITION

MUAC cut-off (cm)	Sensitivity (%)	Specificity (%)	Youden index
<11.0 (n=6)	2.8	100	0.03
<11.5 (n=70)	23.5	99.7	0.23
<12.0 (n=130)	33.5	99.5	0.33
<12.5 (n=288)	63.7	95.8	0.59
<12.8 (n=324)	74.1	93.2	0.67
<13.0 (n=342)	74.5	92.7	0.67
<13.5 (n=850)	85.3	78.7	0.64

A cut-off of 12.8 cm will be difficult to implement in the public health policy context, therefore we recommend to use a 12.5 cm cut-off, as at 12.5 the burden of children without SAM (false-positives) being referred to health facilities for treatment will be much less than at a cut-off of 13 cm. This might have been the wisdom behind the conventional MUAC cut-off levels of 12.5 cm and 13.5 cm.

MUAC is regarded as the best anthropometric measure that indexes the muscle mass directly. However, a study from Ethiopia [15] showed that at all ages, MUAC is more influenced than WFH by body composition measured in terms of Fat Mass variability relative to the fat-free mass variability. Considering that racial difference or different ethnicities has been observed in body composition [12,16], there is a need for conducting a multi-centric study with adequate power to decide best MUAC cut-off for detection of SAM among Indian children. Such a study would help to overcome the limitation of limited external generalizability of the present study as this was conducted in villages under only one PHC area.

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