Mid-upper Arm Circumference for Detection of Severe Acute Malnutrition in Infants Aged Between One and Six Months

This study conducted among 302 infants aimed to determine the most suitable mid-upper arm circumference cut-off to diagnose severe acute malnutrition (weight-for-length <–3 SD) in infants aged between 1 and 6 months. The cut-off of ≤11.0 cm had the best performance (Youden index 0.63, sensitivity 82.5%, specificity 80.3%).

Keywords: *Anthropometry, Infant, Protein energy malnutrition*.

Mid-upper arm circumference (MUAC) cut-off of 11.5 cm is used as an independent diagnostic criterion to identify severe acute malnutrition (SAM) in children aged between 6 months and 5 years [1]. MUAC is useful for the purpose of mass screening and community-based diagnosis. The existing burden of severe wasting (weight-for-length <–3 SD), which is an indicator of SAM [1], in under-five children in India is 6.4% [2]; the prevalence is even higher (13.1%) in infants below 6 months of age [2]. The mortality due to SAM has also been shown to be higher in infants less than six months of age than in older children [3]. However, role of MUAC in diagnosis of SAM below the age of 6 months of age has not been studied adequately.

This hospital-based study was conducted in the Department of Pediatrics, University College of Medical Sciences and GTB Hospital, Delhi, India from July 2013 to April 2014. Infants aged between one to six months attending the outpatient department or admitted in the pediatric ward were screened. Infants showing clinical evidence of edema, ascites, pleural effusion, a significant tumor or mass, or length < 45 cm were excluded. Parental consent was obtained, and ethical clearance was obtained from the Institutional Ethics Committee. Weight, length and MUAC of all infants were recorded using standard procedures [4]. Electronic weighing scale (Equinox, BE-EQ 22, India) with a sensitivity of 10 g was used for recording the weight. Non-stretchable plastic tape was used to measure MUAC. Weight-for-length Z-scores (WLZ) was calculated using 'WHO Anthro for PC' software [5]. Sensitivity, specificity, Youden index (sensitivity+specificity-1), and the likelihood ratio of positive and negative tests were calculated for MUAC cut-offs of 9.5 cm, 10 cm, 10.5 cm, 11 cm, 11.5 cm, and 12 cm against the presence of SAM (WLZ <–3). Receiver operating characteristic (ROC) was plotted, including the area under the curve with 95% confidence interval (CI) using Medcalc software (Version 13.3.3.0) to assess the optimal MUAC cut-off point [6].

We approached 310 infants for the study; 302 (180 males) were finally included. One-third of the participants (*n*=101) were enrolled from the pediatric ward. The mean (SD) age of the subjects was 99.5 (49.1) days. The number of infants aged between 1-2 months, 3-4 months , and 5-6 months were 147 (48.7%), 97 (32.1%), and 58 (19.2%), respectively. The mean (SD) weight, length, and MUAC were 4.73 (1.37) kg, 58.4 (5.0) cm and 11.6 (2.0) cm, respectively. The number of infants with WLZ >–2, between –2 and –3, and <–3, were 176 (58.2%), 63 (20.9%) and 63 (20.9%) respectively. The sensitivity, specificity, Youden index, and the likelihood ratio of positive and negative tests of different MUAC cut offs for diagnosing SAM have been presented in the ***Table* I**. The MUAC cut-off ≤11.0 cm yielded the highest Youden index of 0.63 and had high sensitivity (82.5%) and specificity

TABLE I EVALUATION OF DIFFERENT CUT-OFFS OF MID-UPPER ARM CIRCUMFERENCE (MUAC) for Diagnosis of SAM (*N*=302)

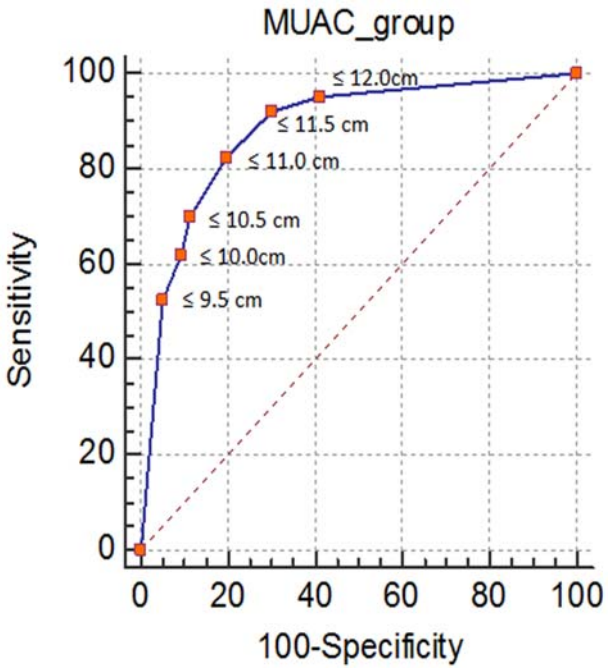
S.No.	*MAC Cut off (cm)*	*Sensitivity (%)*	*Specificity (%)*	*Youden Index*	*LR +*	*LR -*
1.	≤12.0	95.2% (60/63)	59.0% (141/239)	0.54	2.32	0.08
2.	≤11.5	92.1% (58/63)	69.9% (167/239)	0.62	3.06	0.11
3.	≤11.0	82.5% (52/63)	80.3% (192/239)	0.63	4.20	0.22
4.	≤10.5	69.8% (44/63)	88.7% (212/239)	0.59	6.18	0.34
5.	≤10.0	61.9% (39/63)	90.8% (217/239)	0.53	6.72	0.42
6.	≤9.5	53.7% (34/63)	95.0% (227/239)	0.49	10.43	0.50

SAM: Severe acute malnutrition; LR +: Likelihood ratio for positive test; LR -: Likelihood ratio for negative test.

(80.3%). ***Fig.* 1** shows the ROC curve comparing the MUAC cut-offs; the best performance was that of 11.0 cm. The total area under ROC curve was 0.884 [95% CI: 0.842, 0.918; *P*<0.001].

The limitations of the study include the hospital-based setting involving a convenience sampling. The MUAC cut-offs also need to be studied with the functional outcomes such as risk of infections, morbidity, and related mortality.

With the use of WHO growth standards published in 2006 [7], MUAC cut-off of ≤11.5 cm is used to diagnose SAM in the age group 6 months-5years [1]. MUAC cut-off of ≤12.0cm has been suggested to be more suitable to diagnose SAM in the Indian setting [8]. MUAC was shown to be more reliably measured by the community health workers than WLZ in infants less than 6 months of age [9]. Another study has suggested using MUAC cut-off of ≤11.0 cm to identify infants in the age group 6-14 weeks with a markedly increased risk of death [10]. The results of the present study support that the MUAC cut-off of ≤11.0 cm can be used for diagnosing SAM in infants below the age of 6 months.



**Values of sensitivity and specificity in percent.*

***Fig.* 1** *Receiver operating characteristic curve.*

SIDDHARTH CHAND AND *DHEERAJ SHAH
Department of Pediatrics,
University College of Medical Sciences and GTB Hospital,
Dilshad Garden, Delhi, India.
**shahdheeraj@hotmail.com*

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