

## Validation of Mid-upper-arm Circumference Cut-offs to Diagnose Severe Wasting in Indian Children

This study aimed to assess the sensitivity, specificity, predictive values, and Youden index for mid-upper-arm-circumference cut-off of 115 mm to diagnose severe wasting (as defined by the revised WHO standards) in 346 underweight children aged 6 months to 5 years from an outpatient setting. A cut-off of 115 mm had a better performance (sensitivity 43.2%, specificity 90%, Youden index 0.32) than 110 mm (sensitivity 26.4%, specificity 95.9%, Youden index 0.22) in diagnosing severe wasting. The best performance in terms of a balance between sensitivity and specificity was that of 120 mm (sensitivity 74.4%, specificity 77.8%, Youden index 0.52).

**Key words:** Anthropometry; Malnutrition; Reference standards; Severe acute malnutrition.

Mid-upper-arm circumference (MUAC) is often used as a surrogate measure for defining severe acute malnutrition (SAM) in under-five children for the purpose of mass screening and community based diagnosis as it is easy to perform even in the field and has a good sensitivity and specificity to diagnose severe wasting [1,2]. MUAC cut-offs of 125 mm (indicating global malnutrition) and 110 mm (indicating severe wasting) were in use for all under-five children till recently [2]. With the increasing use of WHO growth standards, the cut-off for diagnosing SAM has been changed to 115 mm based on experience from African countries [3]. However, Indian children may differ in body composition and there is a paucity of data validating these cut-offs in Indian setting.

The present hospital based study enrolled 346 underweight (weight for age less than -2 SD of WHO

growth standards) children aged 6 mo – 5 y over a period of two months. Those with edema, ascites, pleural effusion, or a significant tumor or mass were excluded. The consent of the parent/care givers for participation of their children in the study was obtained, and ethical clearance was obtained from the Institutional Ethical Committee. Weight, height/length and MUAC of all children were recorded using standard procedures [4]. Weight for height Z scores were calculated using ‘WHO Anthro for PC’ software [7]. Sensitivity, specificity, Youden index (sensitivity+specificity-1), and predictive values were calculated for MUAC cut-offs of 110 mm, 115 mm, 120 mm, 125 mm and 130 mm against the presence of severe wasting (weight for length/height Z-score < -3).

The study population included 199 (57.5%) males and 147 (42.5%) females. The mean (SD) age of subjects was 19.3 (12.0) months. The mean (SD) weight, height and MUAC were 7.47 (1.73) kg, 73.5 (8.52) cm, and 12.1 (1.0) cm, respectively. The performance of different cut-offs of MUAC for diagnosing severe wasting is present in **Table I**. On changing the MUAC cut-off from 110 mm to 115 mm, there was a large improvement in sensitivity (16.8% absolute increase, 63.6% relative increase) with a minor reduction in specificity (5.9% absolute reduction, 6.2% relative reduction), and an increase in Youden index from 0.22 to 0.32. The MUAC cut-off value of 120 mm resulted in an absolute increase of 31.2% in sensitivity over 115 mm cut-off, 12.2% decrease in specificity, and the highest Youden index.

Our results reaffirm the WHO stand for changing the MUAC cut off to 115 mm to predict severe wasting, and also in agreement with a recent multicentric study [6] conducted on about 35000 children in 10 countries of Africa and Asia. Our study also suggested that MUAC of 120 mm could prove to be more suitable to predict severe

**TABLE I** EVALUATION OF DIFFERENT CUT-OFFS OF MID-UPPER ARM CIRCUMFERENCE FOR DIAGNOSIS OF SEVERE WASTING (N=346)

Performance parameter	MUAC Cut-off (mm)				
	110	115	120	125	130
Sensitivity	26.4% (33/125)	43.2% (54/125)	74.4% (93/125)	87.2% (109/125)	96.8% (121/125)
Specificity	95.9% (212/221)	90% (199/221)	77.8% (172/221)	50.2% (111/221)	30.8% (68/221)
Positive predictive value	78.6% (33/42)	71% (54/76)	65.5% (93/142)	49.8% (109/219)	44.1% (121/274)
Negative predictive value	69.7% (212/304)	73.7% (199/270)	84.3% (172/204)	87.4% (111/127)	94.4% (68/72)
Youden index	0.22	0.32	0.52	0.37	0.28
LR for positive test	6.48	4.34	3.36	1.75	1.40
LR for negative test	0.77	0.63	0.33	0.25	0.10

LR: Likelihood ratio.

wasting in the Indian setting. These differences may be attributed to difference in body shapes of children belonging to different ethnicities.

The limitations of the study include hospital based enrolment and small sample size. The present study was also limited by its inclusion criteria of only underweight children. The validity of these cut-offs, however, need to be tested in a community setting and also against functional outcomes such as work capacity, morbidity and mortality.

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