

## Short Communication

# Mid upper-arm circumference is an effective tool to identify infants and young children with severe acute malnutrition in India

Victor M Aguayo<sup>1,\*</sup>, Satinder Aneja<sup>2</sup>, Nina Badgaiyan<sup>1</sup> and Karanveer Singh<sup>3</sup>

<sup>1</sup>United Nations Children's Fund (UNICEF), Regional Office for South Asia, PO Box 5815, Lekhnath Marg, Kathmandu, Nepal; <sup>2</sup>Department of Pediatrics, Lady Hardinge Medical College, New Delhi, India; <sup>3</sup>Child Development and Nutrition Programme, UNICEF, New Delhi, India

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### Abstract

**Objective:** To assess the appropriateness of current mid upper-arm circumference (MUAC) cut-offs to identify children with severe acute malnutrition in India.

**Design:** The analysis concerned 6307 children admitted to nutrition rehabilitation centres (2009–2011) where they received therapeutic care as per guidelines by WHO and the Indian Academy of Pediatrics.

**Setting:** States of Jharkhand, Madhya Pradesh and Uttar Pradesh, India.

**Subjects:** Children aged 6–59 months with bilateral pitting oedema or weight-for-height Z-score (WHZ) < -3 or MUAC < 115 mm at admission.

**Results:** Children aged 6–23 months represented ~80% of the admissions. Among them, the proportion with WHZ < -3 was similar to that with MUAC < 115 mm (85.7% *v.* 81.8%); the proportion with MUAC < 115 mm whose WHZ was < -3 was 82.6%; and the proportion with WHZ < -3 whose MUAC < 115 mm was 78.8%. MUAC < 115 mm was as effective as WHZ < -3 in identifying 6–59-month-old children with medical complications (32.2% *v.* 31.6%, respectively), the most important risk factor of death among oedema-free children. Furthermore, death rates in children with MUAC < 115 mm were higher than in children with WHZ < -3 (0.61% *v.* 0.58%, respectively) and 91% of the deaths among oedema-free children were deaths of children with MUAC < 115 mm.

**Conclusions:** In populations similar to those included in our analysis, MUAC < 115 mm appears to be an appropriate criterion to identify children with severe acute malnutrition who are at a greater risk of medical complications and death, particularly among children 6–23 months old.

### Keywords

Severe acute malnutrition  
Severe wasting  
Mid upper-arm circumference  
India

Severe acute malnutrition (SAM) remains a major killer of children, as mortality rates in children with severe wasting – the most widespread form of SAM – are nine times higher than in well-nourished children<sup>(1)</sup>. Current global recommendations indicate that children aged 6–59 months with a mid upper-arm circumference (MUAC) < 115 mm should be admitted to a programme for the management of SAM<sup>(2)</sup>. The latest data available indicate that at any point in time, an average of 8 million Indian under-5s (i.e. an estimated 6.4% of children 0–59 months old) are severely wasted<sup>(3,4)</sup>. This is the largest pool of severely wasted children worldwide.

In this context, India's Ministry of Health has endorsed the use of MUAC < 115 mm as a screening and admission criterion for the management of children with SAM<sup>(5)</sup>.

However, some argue that this cut-off may not be appropriate for Indian children<sup>(6)</sup>. The objective of our analysis was to assess the appropriateness of current MUAC cut-off values in identifying children with SAM in India in order to inform the future design and implementation of national and state programmes for the provision of care for children with SAM.

### Methods

Our analysis concerns 6307 children with SAM admitted to nutrition rehabilitation centres (NRC) in the states of Jharkhand, Madhya Pradesh and Uttar Pradesh between 1 July 2009 and 31 December 2011.

The detection of children with SAM was ensured in the villages by frontline workers either as part of monthly growth monitoring and promotion sessions at the village *anganwadi* centre (passive case finding) or in the context of community drives for the identification of children with SAM (active case finding). All children aged 6–59 months with bilateral pitting oedema or weight-for-height Z-score (WHZ) < -3 or MUAC < 115 mm were admitted to the NRC<sup>(7,8)</sup>.

Upon admission to the NRC, a medical doctor conducted a clinical examination of the children to detect the presence/absence of medical complications using the criteria for the Integrated Management of Neonatal and Childhood Illnesses<sup>(9)</sup>. At the NRC, children received therapeutic care following protocols based on the guidelines for management of SAM by the WHO and the Indian Academy of Pediatrics<sup>(7,8)</sup>. Children were discharged upon completion of a prescribed 14 d stay in the NRC, provided that they were active and alert, had no signs of oedema, fever or infection, had completed all age-appropriate immunizations and their primary caregiver had been informed about follow-up care.

Statistical analyses were carried out using the Stata software package release 12.

**Results**

Among the 6307 children admitted, 3279 (52.0%) were girls, 4023 (63.8%) were from scheduled caste or scheduled tribe families and 5023 (79.6%) were in the age group 6–23 months. On admission, 231 (3.7%) of the children had oedema, 1870 children (29.6%) had severe wasting with medical complications (lethargy, loss of appetite, fever or hypothermia, severe pneumonia, severe dehydration, severe anaemia, malaria and/or tuberculosis) and 4206

children (66.7%) had uncomplicated SAM (free of oedema and medical complications).

The following programme outcomes were recorded: forty-three children (0.7%) died, 1442 children (22.9%) left before discharge (defaulted) and 4822 (76.5%) were discharged. The average length of stay among the discharged was 14.7 (SD 3.2) d and their average weight gain was 9.7 (SD 15.3) g/kg body weight per d. At the time of discharge, 1643 children (34.1%) had gained ≥15% of their initial weight (Table 1).

A total of 6076 children were severely wasted (non-oedematous SAM); among them, the proportion with WHZ < -3 was higher than the proportion with MUAC < 115 mm (85.9% v. 78.1%, respectively). This difference was less pronounced among infants and young children aged 6–23 months (85.7% v. 81.8%) than among older children aged 24–59 months (86.4% v. 63.0%). The proportion of children with both WHZ < -3 and MUAC < 115 mm was significantly higher among infants and young children aged 6–23 months than among older children aged 24–59 months (67.5% v. 49.4%; Table 2).

The proportion of children aged 6–59 months with WHZ < -3 and identified by MUAC < 115 as being severely wasted was 74.4%. This figure decreased with children's age: 78.8% among children aged 6–23 months v. 57.2% among children aged 24–59 months. The proportion of children aged 6–59 months with MUAC < 115 mm and whose WHZ was < -3 was 81.9% and decreased with children's age: 82.6% among children aged 6–23 months v. 78.4% among children aged 24–59 months.

Multivariable logistic regression analysis indicated that the presence of oedema was the most important predictor of death while in the NRC (adjusted OR = 6.98; 95% CI 2.07, 16.4). Eleven (25.6%) of the forty-three children who died had oedema at admission. Death rates in children

**Table 1** Characteristics of 6–59-month-old children (n 6307) at admission and by programme outcome\*, Jharkhand, Madhya Pradesh and Uttar Pradesh, India, 2009–2011

	Exits†		Deaths		Defaulters		Discharged		Recovered‡	
	n	%	n	%	n	%	n	%	n	%
Girls	3279	52.0	19	44.2	737	51.1	2523	52.3	835	50.8
Boys	3028	48.0	24	55.8	705	48.9	2299	47.7	808	49.2
6–11 months old	2166	34.3	16	37.2	487	33.8	1663	34.5	678	41.3
12–23 months old	2857	45.3	15	34.9	668	46.3	2174	45.1	681	41.4
24–59 months old	1284	20.4	12	27.9	287	19.9	985	20.4	284	17.3
SC family	1371	21.7	4	9.3	350	24.3	1017	21.1	361	22.0
ST family	2652	42.0	21	48.8	449	31.1	2182	45.3	782	47.6
Non-SC/ST family	2284	36.2	18	41.9	643	44.6	1623	33.7	500	30.4
With bilateral pitting oedema	231	3.7	11	25.6	74	5.1	146	3.0	39	2.4
Complicated wasting (WHZ < -3 or MUAC < 115 mm and medical complications)	1870	29.6	16	37.2	367	25.5	1487	30.8	1040	63.3
Uncomplicated SAM (WHZ < -3 or MUAC < 115 mm and free of medical complications)	4206	66.7	16	37.2	1001	69.4	3189	66.1	564	34.3
Total	6307	100	43	0.7	1442	22.9	4822	76.5	1643	34.1

SC, scheduled caste; ST, scheduled tribe; WHZ, weight-for-height Z-score; MUAC, mid upper-arm circumference; SAM, severe acute malnutrition.

\*Values are presented as absolute numbers (n) and as percentage of the total (%).

†Exits: deaths + defaulters + discharged.

‡Recovered: children who, at discharge, had gained ≥15% of their initial weight.

**Table 2** Anthropometry and programme outcomes by age group among 6–59-month-old children who were free of oedema at admission\*, Jharkhand, Madhya Pradesh and Uttar Pradesh, India, 2009–2011

	Exits†		Complicated‡		Deaths		Defaulters		Discharged		Recovered§	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Children aged 6–23 months												
WHZ < -3	4175	85.7	1358	34.3	23	0.55	936	22.4	3216	77.0	1206	37.5
MUAC < 115 mm	3983	81.8	1294	32.9	23	0.58	892	22.4	3068	77.0	1166	38.0
WHZ < -3 and MUAC ≥ 115 mm	887	18.2	248	34.3	2	0.23	210	23.7	675	76.1	168	24.9
MUAC < 115 mm and WHZ ≥ -3	695	14.3	184	25.5	2	0.29	166	23.9	527	75.8	128	24.3
MUAC < 115 mm and WHZ < -3	3288	67.5	1110	34.3	21	0.64	726	22.1	2541	77.3	1038	40.9
Total	4870	100.0	1542	33.1	25	0.51	1102	22.6	3743	76.9	1334	35.6
Children aged 24–59 months												
WHZ < -3	1042	86.4	289	27.7	7	0.67	229	22.0	806	77.4	238	29.5
MUAC < 115 mm	760	63.0	232	30.5	6	0.79	155	20.4	599	78.8	201	33.6
WHZ < -3 and MUAC ≥ 115 mm	446	37.0	96	21.5	1	0.22	111	24.9	334	74.9	69	20.7
MUAC < 115 mm and WHZ ≥ -3	164	13.6	39	23.8	0	0.00	37	22.6	127	77.4	32	25.2
MUAC < 115 mm and WHZ < -3	596	49.4	193	32.4	6	1.01	118	19.8	472	79.2	169	35.8
Total	1206	100.0	328	27.2	7	0.58	266	22.1	933	77.4	270	28.9
Children aged 6–59 months												
WHZ < -3	5217	85.9	1647	31.6	30	0.58	1165	22.3	4022	77.1	1367	34.0
MUAC < 115 mm	4743	78.1	1526	32.2	29	0.61	1047	22.1	3667	77.3	1444	39.4
WHZ < -3 and MUAC ≥ 115 mm	1333	21.9	344	25.8	3	0.23	321	24.1	1009	75.7	160	15.9
MUAC < 115 mm and WHZ ≥ -3	859	14.1	223	26.0	2	0.23	203	23.6	654	76.1	237	36.2
MUAC < 115 mm and WHZ < -3	3884	63.9	1303	33.5	27	0.70	844	21.7	3013	77.6	1207	40.1
Total	6076	100.0	1870	30.8	32	0.53	1368	22.5	4676	77.0	1604	34.3

WHZ, weight-for-height Z-score; MUAC, mid upper-arm circumference.

\*Values are presented as absolute numbers (*n*) and as percentage of the total (%).

†Exits: deaths + defaulters + discharged.

‡Complicated: children who, at admission, had oedema or medical complications.

§Recovered: children who, at discharge, had gained ≥15% of their initial weight.

with oedema were nine times higher than those in oedema-free children. Among oedema-free children, the most important predictor of death was the presence of medical complications (adjusted OR = 2.43; 95% CI 1.28, 4.06). Death rates in oedema-free children with medical complications were 2.3 times higher than in children with uncomplicated severe wasting.

Among oedema-free children, the proportion of children with medical complications was similar in children with MUAC < 115 mm and children with WHZ < -3 across all age groups (32.5% *v.* 32.5% in infants and young children aged 6–23 months; 32.2% *v.* 31.6% in children aged 24–59 months; and 26.0% *v.* 25.8% among children aged 6–59 months; data not presented). The proportion of deaths among oedema-free children with MUAC < 115 mm was higher than among children with WHZ < -3 (0.61% *v.* 0.58%). Mortality rates among children with MUAC < 110 mm were four times higher than among children with 110 mm ≤ MUAC < 115 mm.

## Discussion

Our findings must be interpreted keeping in mind two factors that limit their applicability to the general child population of India: (i) the data analysed apply to three samples of children that may not be representative of the general population of children in Jharkhand, Madhya Pradesh, Uttar Pradesh or India, as the villages where screening, referral and treatment took place were not

randomly selected; and (ii) although in the villages covered by the NRC included in the analysis all efforts were made to screen, refer and treat all eligible children, the analysis presented here applies to the programme data collected on the children who were actually screened, referred and treated, whose characteristics at admission and response to treatment may not be representative of the child population at large.

However, on the basis of the results it seems legitimate to conclude that in populations in India similar to those included in our analysis, MUAC < 115 mm appears to be at least as effective as (if not more effective than) WHZ < -3 to identify SAM children at a greater risk of medical complications and death, particularly among 6–23-month-old children, who represent the vast majority (~ 80%) of the caseload of children with SAM.

In this population, MUAC < 115 mm was effective in identifying children with SAM, particularly among young children aged 6–23 months. Among them, the proportion with WHZ < -3 was similar to that with MUAC < 115 mm (85.7% *v.* 81.8%), with a significant overlap between both groups: the proportion of children aged 6–23 months with MUAC < 115 mm whose WHZ was < -3 was 82.6%; and the proportion of children aged 6–23 months with WHZ < -3 whose MUAC < 115 mm was 78.8%. Importantly, MUAC < 115 mm was as effective as WHZ < -3 in identifying children with medical complications (32.2% *v.* 31.6%, respectively), the most important risk factor of death among oedema-free children. Furthermore, death

rates in children with MUAC < 115 mm were higher than in children with WHZ < -3 (0.61% *v.* 0.58%, respectively): 91% of the deaths among oedema-free children were deaths of children with MUAC < 115 mm. Death rates were four times higher among children with MUAC < 110 mm than among children with 110 mm ≤ MUAC < 115 mm; thus as many as 88% of deaths among oedema-free children were deaths of children with MUAC < 110 mm.

Two recent studies, one in India<sup>(6)</sup> and one in Cambodia<sup>(10)</sup>, have questioned the reliability of MUAC for the identification of children with SAM; they both focus on the ability of MUAC < 115 mm to identify children with WHZ < -3, which is referred to as the 'gold standard' of case definition in both papers.

The differences between our findings and those in the study in India could be explained by methodological issues, as the latter short research letter reports findings on a purposive sample of children in a few villages in Madhya Pradesh with an extremely high prevalence of severe wasting and severe stunting<sup>(6)</sup>.

The differences between our findings and those in the study in Cambodia could be explained by epidemiological differences. The latest national data available indicate that while the prevalence of moderate and severe stunting in children is very high (≥40%) in both Cambodia and India, the prevalence of moderate and severe wasting is twice higher in India than in Cambodia (20% *v.* 11%, respectively)<sup>(11)</sup>. Furthermore, the prevalence of severe wasting in the Cambodia sample is 4.5 times lower than in India, indicating that the epidemiology of wasting (both extent and severity) in these two settings may be significantly different. The Cambodia paper does not provide any information on the prevalence of stunting or the mean height-for-age Z-score in children. Therefore comparisons in this respect are not possible.

An extensive literature documents the advantages of using MUAC for the screening and admission of children with SAM. Besides the simplicity of the use of MUAC and the ability to allow for high coverage, these reviews emphasize its superior effectiveness to identify children at high risk of death; they also indicate that there is no benefit in using WHZ < -3 in addition to MUAC < 115 mm as MUAC identifies high-risk children better than WHZ < -3<sup>(12,13)</sup>. Moreover, the new global guidance by WHO indicating that MUAC ≥ 125 mm (without oedema for at least two weeks) should be used as discharge criterion for children admitted with MUAC < 115 mm can significantly simplify national protocols, the training and supervision of the staff involved in identifying and treating children, and the overall performance of programmes for the management of SAM<sup>(14)</sup>.

## Conclusion

Our findings support the overall appropriateness of India's Ministry of Health endorsement of the use of

MUAC < 115 mm as simple, affordable and evidence-based tool that community health workers can use as a screening and admission criterion in the management of children with SAM<sup>(3,9,10)</sup>. Active identification and early treatment of children with oedema and/or MUAC < 115 mm should be the primary focus of programmes for the management of SAM in India, particularly among infants and young children 6–23 months old. Children with oedema and/or medical complications and/or MUAC < 115 mm should be treated in a NRC as they are at a significantly higher risk of death, whereas children free of oedema and medical complications – at a much lower risk of death – should be appropriately managed in their communities to improve their nutritional status and avoid the onset of life-threatening conditions.

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