

# Detection of Malnutrition in Older Infants by Measurement of Mid arm Circumference

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## Abstract

**Introduction-** Mid-arm circumference (MAC) has been widely used as an age-independent indicator of undernutrition at 1-5 years of age. Its role below one year of age has not been extensively studied. Growth faltering which predicts protein-energy malnutrition (PEM) usually begins between ages 6 and 12 month. This study aimed to determine the age-independent character of MAC within 7-11 month age group and search for a reliable cut off point. **Methods-** This institutional based, cross-sectional, observational study was done at three government hospitals including a teaching tertiary level hospital. Study variables were age, sex, height, body weight & mid arm circumference. Mid arm circumference was validated against weight for age percentage and Standard deviation score. **Results-** Mean MAC of the infants increased very little with age from 7-11 months. The cut off points from 13.0 to 12.5 cm showed maximum diagnostic accuracy. **Conclusions-** MAC measurement is a simple and valid tool for detection of early PEM in this crucial age bracket However, further studies are suggested, preferably community based and in a larger sample to establish the validity of MAC to detect PEM in infants.

**Key words:** MAC, PEM, infants

## Introduction

Malnutrition in infancy often goes undetected in developing countries due to deficiency of healthcare facilities and lack of simple and feasible screening techniques. Detection and early intervention at this stage can correct the nutritional deficiencies. Peripheral healthcare workers need a simple and feasible technique to detect malnutrition particularly when a functioning weight machine is not always available. The MAC is a

simple, sensitive and cost effective tool for community assessment of nutritional status in children above six months of age<sup>1, 2, 3, 4</sup>. Its measurement is relatively easy to perform and requires minimal time and effort.

Growth faltering, which may indicate protein-energy malnutrition (PEM) usually begins between ages 6 and 12 months<sup>1, 2</sup>.

In breast fed babies malnutrition may start around six months of age as improper complimentary feeds may be introduced and there may be sudden withdrawal of breast feeds<sup>5</sup>. Intercurrent infections like diarrhoea and acute respiratory infections also hasten

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malnutrition. Most of the PEM are mild to moderate and may go unnoticed unless it is specifically looked for. Thus, identification of malnutrition as early as possible in this period is crucial.

A recent WHO statement recommends MUAC cut offs of <115mm in children aged 6-60 months for identifying severe acute malnutrition.

Weight for height <-3SD, MUAC <115mm & bilateral oedema have been considered as independent indicators of SAM that require urgent action <sup>6</sup>.

Mid-arm circumference (MAC) has thus been extensively used at 1-5 years of age as an age-independent indicator of protein-energy malnutrition.

Studies to detect malnutrition by measuring Mid Arm Circumference during second half of infancy are very few <sup>1, 2, 3, 5, 7, 8</sup>.

A search for a clinically reliable cut-off point has not been systematically done. In fact, MAC may be the single available tool, which can help health workers to identify malnutrition at an early stage.

Mean MAC does not rise substantially during the second half of infancy as proposed by researchers and so can be deemed to be an age independent variable from 6 months onwards.

A single cut off value, if found, can be useful for early detection of malnutrition. The present study was done to assess if MAC is a useful tool for early detection of malnutrition among 7-11 month old infants and identify its validity characteristics in this age group.

**Material & Method**

We conducted an urban hospital based, observational, cross sectional study. 178 infants randomly selected from OPD & immunization clinics of Kamla Nehru Hospital, Jai Prakash Hospital and Government Hospital, Bairagarh were the study group.

Study was carried on between June 2011 to December 2011. Only babies who were brought for routine monthly check up and immunization were included.

Each infant selected for the study was weighed on a digital weighing machine noted to nearest of 100gm.

(Weight was taken by a Salter's balance, Model 235PBW) and the calibration of the weighing scale was checked daily with a known weight.

The MAC measurements were taken by a flexible non-stretchable tailor's cloth tape, on the left upper arm at the point midway between the tip of the acromian process of scapula and tip of olecranon process of ulna, and were recorded to nearest 1 mm<sup>8</sup>.

All variables like age, sex, residence and examination findings were noted in a pre-designed Performa.

Infants between 7-11 months with/without malnutrition were arranged according to MUAC values. The values at and above the cut off points were considered as normal & the values below were considered abnormal.

The position of the cut-off points determined the Total Positive, Total Negative, Positive Predictive Value, Negative Predictive Value & diagnostic accuracy (2x2 contingency table).

Data was collected, tabulated & analysed on SPSS16 (Statistical Package for Social Sciences 16). In this study "PEM" was taken as body weight less than mean-2SD for that particular age<sup>9</sup>.

**Results**

178 infant in age group of 7-11 months attending OPD and immunization clinics of above mentioned hospitals from June 2011 to Dec 2011 were studied.

Out of 178 infants, 88 (49.44%) were male (Table No.1). Prevalence of PEM (i.e. weight < "mean-2SD limits" for the age) was 43 (24.16%).

Table No.1: Age and Sex wise distribution of cases

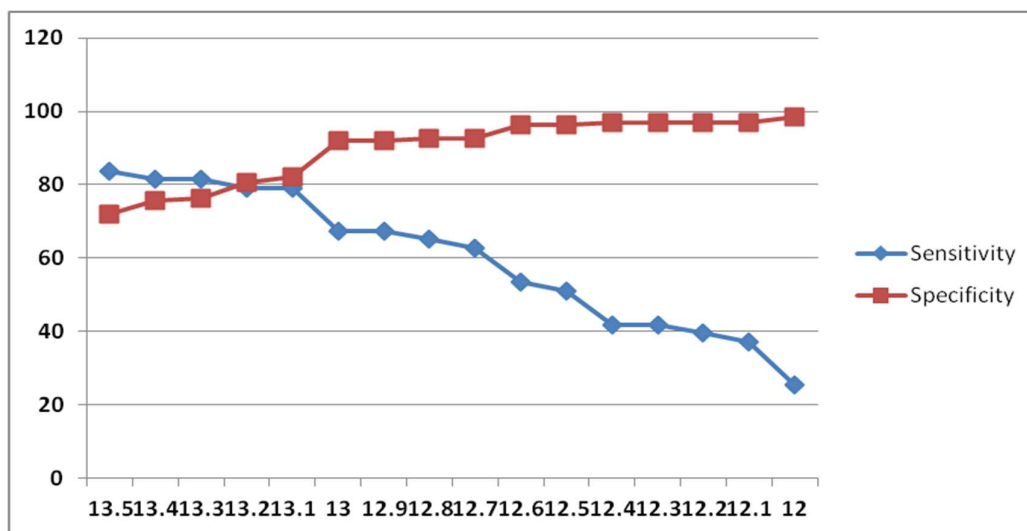
Age (months)	Male			Female			Total			Sex difference (t value)	P value
	No	Mean	SD	No.	Mean	SD	No.	Mean	SD		
7	15	13.09	0.59	17	12.71	0.56	32	12.80	0.64	1.87	0.07
8	17	13.05	0.67	18	13.01	0.51	35	13.03	0.62	0.25	0.80
9	14	13.09	0.67	17	13.12	0.44	31	13.11	0.58	0.10	0.10
10	20	13.24	0.64	21	13.17	0.38	41	13.20	0.54	0.37	0.37
11	22	13.35	0.59	17	13.33	0.34	39	13.34	0.51	0.19	0.85
<b>Total</b>	88	13.18	0.59	90	13.07	0.56	178	13.13	0.64	1.28	0.20

Mean MAC of the infants increased very little with age from 7-11months. The overall increase in MUAC was 0.44% of total, (0.26% for males & 0.62% for females) and these changes were found to be statistically insignificant ( $p>0.05$ ).

Male infants between 7-11months in general possessed higher mean value for MUAC than their female counterparts except at 10 months of age. Magnitude of sex difference in 7-11 months was statistically insignificant ( $p\leq 0.05$ ). We did not find any differences between the measurements taken at the three hospitals.

Table No.2 & Figure I shows the validity characteristics of different levels of MAC to detect PEM among the age group 7-11 month infants.

The cut off points from 13.0 to 12.5 cm showed maximum diagnostic accuracy of about 86% suggesting a correct diagnosis (i.e. true positive & true negative) of PEM. At 13 cm cut off point, a high sensitivity of 67.44% and specificity of 91.85% was noted, while on the other hand at 12.5 cm, sensitivity of about 51.16% (true positive) and the specificity was 96.30% (leaving very few false positive/ misdiagnosis) and with overall correct diagnosis of around 85.39%.



**Table No.2: Validity characteristics of different levels of MAC to detect PEM among 7-11 month Infants**

Validity characteristics of different levels of MAC to detect PEM (n=178)					
MAC cut off(cms)	Sensitivity	Specificity	Positive Predictive value	Negative Predictive value	Diagnostic accuracy
13.5	83.72	71.85	48.65	93.27	74.72
13.4	81.40	75.56	51.47	92.73	76.97
13.3	81.40	76.30	52.24	92.79	77.53
13.2	79.07	80.74	56.67	92.37	80.34
13.1	79.07	82.22	58.62	92.50	81.46
13	67.44	91.85	72.50	89.86	85.96
12.9	67.44	91.85	72.50	89.86	85.96
12.8	65.17	92.59	73.68	89.29	85.96
12.7	62.80	92.59	72.97	88.65	85.39
12.6	53.49	96.30	82.14	86.67	85.96
12.5	51.16	96.30	81.48	86.09	85.39
12.4	41.86	97.04	81.82	83.97	83.71
12.3	41.86	97.04	81.82	83.97	83.71
12.2	39.53	97.04	80.95	83.44	83.15
12.1	37.21	97.04	80.00	82.91	82.58
12	25.58	98.52	84.62	80.61	80.90

## Discussion

The present study shows that MAC of an infant within 7-11 months shows very little change. We observed an overall increase in MAC of 0.44%. Similar findings were observed in the study conducted by Bhalla AK<sup>2</sup> amongst Punjabi infants aged 8-11 month of age, by Martorell R et al<sup>10</sup> among Guatemalan infants aged 9-12 months & by Sadhukhan SK et al<sup>5</sup> among Bengali rural infants.

Thus, the study supports the finding that mean MAC of infants was almost constant and could be considered to be almost age independent.

It was observed that MAC level from 13 to 12.5 cm had the maximum diagnostic power (about 86%) and MAC level of 12.5(12.6) cm had the minimum false positivity (only around 4%).

Also at MAC value of 12.5 cm, the positive & negative predictive values of 81.5% & 86.1% were favourable with a very high likelihood ratio of 13.9 (close to maximum value of 17.3). In one study it was observed that MAC level from 13 to 12.5cm had the maximum diagnostic accuracy<sup>5</sup>.

MAC of 12.5cm produced a high sensitivity & specificity in another study too<sup>2</sup>. Bhatia RC et al<sup>3</sup> found MAC to be age independent with overall increase of 5.1%. A value of 12.5cm had the maximum specificity in their study.

Pust R et al<sup>1</sup> observed that MAC <12.5cm may provide a simple & valid screening test for early PEM between 6-12 months of age. One study found that MAC, with the addition of bipedal oedema, was found to be the indicator best suited for screening & case detection of malnutrition in the community<sup>4</sup>.

In our study, with the use of MAC alone at 12.5 cm, around 51% of undernourished infants could be detected. Thus, MAC measurement can have many practical advantages over the standard anthropometry, especially at the community level as has been documented in other studies<sup>1,3</sup>.

## Conclusions

MAC is, therefore, a simple, age independent, cost effective and measurement for early assessment of PEM by using single cut-off point and can serve as a screening test for early detection of malnutrition in infants.

MAC can provide a viable alternative to other cumbersome methods in use in field surveys.

Early intervention in such children can prevent their progression to more severe grades of malnutrition. It can thus be put to use in community for meaningful utilization of nutritional programmes.

However, we suggest further studies, preferably community based and in a larger sample to establish the validity and threshold of MAC to detect malnutrition.

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**Conflict of interest:** Nil

**Permission from IRB:** Yes

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