Mid Upper Arm Circumference for age as a measure of undernutrition among underprivileged children in Delhi

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Abstract- MUAC is used as an indicator for assessing acute undernutrition among children below five years of age. WHO child growth standards (2006) have given age related z-scores for both boys and girls for MUAC for identification of acute undernutrition among children below five years. A total of 4737 observations for MUAC had been made on 2305 children below 6 years of age living in an urban slum of Delhi in this cross-linked study. MUAC was measured using fibreglass tape sensitive to the nearest mm using standard technique. MUAC z-scores (MUACZ) were computed using WHO child growth standards and nutritional status was assessed. Median MUACZ for both boys and girls was much lower than median value of MUAC for boys and girls in WHO Child Growth Standards (2006). There was no significant difference in mean values of MUAC between the boys and girls upto 4 years of age. It was observed that 53.9% of the children (age-combined) were undernourished (below -2SD MUACZ), of which 11.2 % had severe acute malnutrition (below -3 SD MUACZ). The single cut-off point for MUAC <12.5 cm underestimated the prevalence of undernutrition was 32.6% among children in the study. This clearly indicated that MUAC-for-age using WHO Child Growth Standards would help in identifying the burden of acute undernutrition among underprivileged children.

Index Terms-MUAC, MUAC z-scores, weight-for-height, WHO Child Growth Standards, undernutriton

1.INTRODUCTION

Undernutrition during childhood has implications on growth potential and the risk of morbidity and mortality in later years of life (Alderman et.al, 2003). Chronic under-nutrition in childhood is linked to slower cognitive development and serious health impairments later in life that reduce the quality of life of individuals (Scrimshaw, 1996). Repeated infections and inadequate food intake result in acute forms of undernutrition which can be corrected with timely referral and adequate dietary intake. Improved child health and survival has far reaching implications for the better development of future generations (WHO, 1986).

Wasting is used as an indicator for acute undernutrition, often assessed by weight-for-height and Mid-Upper Arm Circumference (MUAC). MUACis commonly used as a measure for subcutaneous fat and muscle mass in children. Reduced food intake subsequently reduces subcutaneous fat and muscle mass which tend to decrease MUAC. MUAC has been observed to correlate better than weight-for-height with lean mass ratio(Myatt and Duffield, 2007). LMR is the ratio of estimated mass of limbs to estimated mass of trunk. Compared with weight-for-height, a sensitivity of 24.6% and a specificity of 94.8% had been reported for MUAC (Joseph , 2002) and it appears to be a better predictor of childhood mortality than weight-for-height (Briend, 1986).

Over the years MUAC is being used as an age independent criterion for assessing acute undernutrition among children. Simplicity in measurement and easy interpretation has resulted in its use as a diagnostic criterion to identify acute undernutrition among preschool children during emergencies or where the precise age is not known. For screening of severe acute malnutritionamong children aged between 6 months and five years MUAC <11.5 cm is used as a criterion in both facility based and community based management programme (GOI, 2011). Some studies conducted in urban slums of Delhi have raised concerns regarding use of single cut-off based MUAC as a screening tool for identification of SAM children (Dasguptaet.al., 2013; Chand and Shah, 2015). It has been pointed out that MUAC as a screening tool should not be identifying less children than WHZ (the ‘gold standard’).

WHO child growth standards (2006) standards had given age related standards for MUAC for children upto five years of age.This paper analyses the data on MUAC of children belonging to low income families against this yardstick.

II. METHODOLOGY

A cross-linked study was designed as it allows follow-up over a relatively wide age range within a relatively short time span (Kowalski and Anderson, 1979) and provides an opportunity to make up for the sample loss, by enrolling new subjects at any requisite age points (Goldstein, 1987). It was carried out in Northwest Delhi on children below 6 years belonging to low income families availing services from Anganwadi centres (AWCs) of Integrated Child Development Scheme of the Government of India. The sample size was calculated from the findings of baseline survey on prevalence of undernutrition (9%, BMI-for-age <-2SD) among children and 25 % morbidity. It was estimated to be 5066, at 95% level of significance and 80 % power precision.

The data were collected at three month intervals (total of 12 contact points) for a period of three years from August 2006 to April 2010 fromsix AWCs located in an urban slum of Haiderpur, Northwest Delhi. A total of 2305 children availing services from these AWCs were enrolled during the study. On an average, number of children covered in each round was 527± 64 providing a total of 6334 set of independent observations in twelve rounds. Multiple observations were available for each child at different intervals during the study, each observation was assumed to be an independent observation and was analyzed cross-sectionally (n=6334).

A pre-tested questionnaire was used to elicit information from the primary caregivers (mothers/grandmothers/fathers) on socioeconomic and demographic profile at the time of enrolment of the children in the study. The data included family type, family size, religion, education level, occupation and per capita income of the family members, type of house, source of drinking water and toilet facility. The economic status was assessed by obtaining information on various economic assets like ownership of house, mode of transport, cooking utensils, and mode of entertainment accessed by the families of the children.Age was calculated by subtracting the date of birth from the date of interview. Information on date of birth was obtained from immunization cards if available or by asking at least one parent using a calendar of local events or from AWW's records.The WHO Anthro software was used to randomly assign a date in case of those children (18.2%) for whom only month and year of birth was available. For analyses, age was grouped in to twelve months intervals.

Anthropometric measurements was obtained using standard equipments and techniques. Weight was measured on UNICEF SECA scale with 100 g sensitivity. Recumbent length was measured using infantometer and height using wall mounted microtoise. Mid upper arm circumference (MUAC) was measured to the nearest mm on the left arm using a fibreglass tape with vernier attachment (Ramachandran, 1986). It was measured for the children above 3 months of age and who willingly allowed the measurement to be taken without crying. A total of 4737 observations were made for MUAC during the study period. All instruments were calibrated from time to time before each round. Quality control was maintained in each round by taking measurements in duplicate for every tenth child. Total Error of Measurement (TEM, Uljaszek and Deborak, 1999) was not significant and an excellent concordance was observed between the duplicate readings for MUAC measurements.

Data Analysis

The data were organized and systematically tabulated in Microsoft Excel 2007 and SPSS 16.0 software was used for data analysis. Mean, median and SD of MUAC for each age group and sex was computed. WHO Anthro software (2006) was used to obtain z-scores for weight-for-age (WAZ), Height-for-age (HAZ), weight-for-height (WFH) and MUAC-for-age (MUACZ) for all children. The prevalence of undernutrition was computed using WHO Child Growth Standards (2006). The assessment of nutritional status using MUAC was also done using single cut-off point classification (WHO, 1983) and by age and sex specific criteria for MUAC by WHO, 1995 based on US children in addition to WHO Child Growth Standards (2006) for comparison (Table 1). All results were tested at 5 % level of significance.

Table 1: Classifications used for assessing nutritional status of children using MUAC

Classification	**MUAC (cm)**	
WHO, 1983 (age and sex independent)	MUAC <12.5 cm - Severely undernourished	
	MUAC between 12.5-13.5cm - Mild to moderate undernutrition	
	MUAC >13.5 cm - Normal/satisfactory	
WHO, 1995		
Age	Boys (MUAC cm)	Girls (MUAC cm)
2+ year	13.6	13.4
3+ year	13.8	13.6
4+ year	14.1	13.9
5+ year	14.2	14.1
WHO, 2006		
Undernutrition	Boys (<-2SDMUACZ)	Girls (<-2SD MUACZ)
Severe undernutrition	Boys (<-3SD MUACZ)	Girls (<-3SD MUACZ)

III. RESULTS

General profile of the households

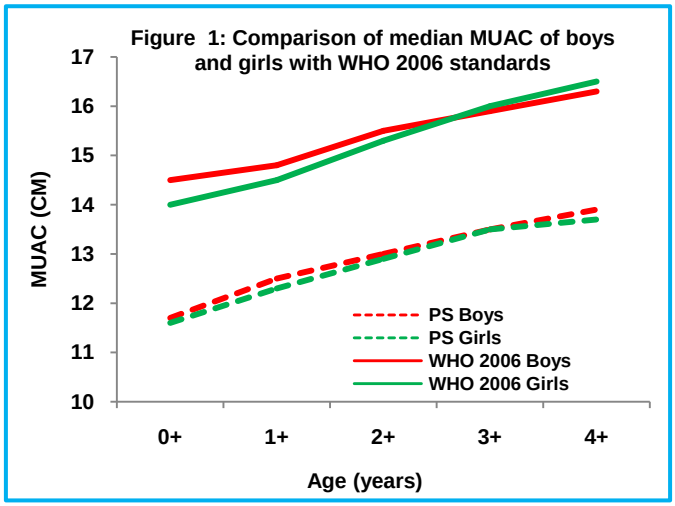
Household members of 75 % families were living in one room rented houses with shared toilet facilities. Only 18.2 % had own flush at home. Majority of the families (90%) of the children were living as nuclear families with mean family size of 4.9 ± 1.21 members. Illiteracy levels were higher in mothers (58.2 %) as compared to fathers (25.1%). Fathers were employed as unskilled labourers, small vendors and rickshaw pullers. Majority of the mothers were housewives and only 12% of the mothers were gainfully employed. Half of the families had monthly per capita income between Rs. 1000- Rs. 1500.

MUAC profile of children

A total of 4737 observations were made on children during the study period. The mean, medianand standard deviation for MUAC of boys (n=2295) and for girls (n=2442) is given in the Table 2. There was no significant gender difference in mean MUAC at all ages upto the age of 4 years except at 12-23 months of age. Other studies had also reported that the gender differences became evident at the age of 4 years. This could be due to the result of differential rate of fat deposition at this site between the sexes (Mandal and Bose 2009, Kaur et al 2005). Studies conducted on 1-5 years old children living in Silchar, Cachar district in Assam(Shareef and Manoj, 2016) and on 3-5 years old children from Chapra district, West Bengal (Biswas et, al., 2010) had reported no significant gender difference between the two sexes.

Table 2: MUAC (cm)profile of underprivileged children (n-4046)

Age (months)	BOYS				GIRLS				Mean Δ	% Δ	't'-value
	n	Mean	Median	SD	n	Mean	Median	SD			
0-11 m	146	11.9	11.7	0.95	136	11.7	11.6	0.91	0.1	1.18	1.136
12-23 m	406	12.5	12.5	1.01	453	12.3	12.3	1.04	0.2	1.64	2.154*
24-35 m	488	12.9	13.0	1.11	502	12.8	12.9	1.09	0.1	0.52	-0.698
36-47 m	463	13.4	13.5	1.14	570	13.4	13.5	1.23	0.0	-0.09	-0.029
48-59 m	426	13.8	13.9	1.19	456	13.6	13.7	1.27	0.2	1.13	2.755*
60-71 m	366	14.0	14.1	1.38	325	13.8	14.0	1.11	0.1	0.53	2.824*
0-71 m	2295	13.1	13.1	1.32	2442	13.1	13.1	1.31	0.0	0.00	-0.035
**, unpaired t-test between boys and girls, t-value significant at p<0.05*											



The median MUAC values for both boys and girls in the present study were parallel but much lower as compared to their respective median MUAC values of WHO Child Growth Standards(2006) for 3-60 months of age (Figure 1). The trend in gender difference of the present study is similar to the WHO standards (2006) for MUAC from 3 to 36 months of age. However, unlike the WHO standards, the girls in the present study continued to have lower median MUAC even after the age of 47 months.

Assessing nutritional status using MUAC-for-age as an index

The nutritional status of children based on MUAC-for-age using WHO Child Growth Standards (2006)is presented in Table 3. It was observed that 53.9% of the children (age-combined) were undernourished (below -2SD); with boys-58.1% and girls-50.1%. Further, in the present study, MUAC-for age (<-2SD, 53.9%) identified maximum number of undernourished children slightly less that Height-for-age (<-2SD, 55%) as compared to weight-for-age (<-2SD, 44%), weight-for-height (<-2SD, 16 %) and BMI-for-age (<-2 SD,13 %). It clearly showed weight-for-height underestimated the prevalence of acute undernutrition at high rate of stunting.

The prevalence of undernutrition in the present study was higher than the 0-5 years old children (36%) living in urban coastal areas of Orissa (Chakarbarthy et al, 2008) and 3-5 year children residing in Chapra Block, Nadia District, West Bengal (Biswas et al, 2010). The West Bengal study also reported higher prevalence of undernutrition among boys (38.49%) as compared to girls (32.22%). In the present study also, the prevalence of undernutrition was higher among boys as compared to girls at all ages (Table 3).

The maximum prevalence of undernutrition was in first two years of life on the basis ofMUAC-for-age and which decreased with increase in age (Table 3). This was reported by other studies as well (Kumar et al, 2006, Kaur et al, 2005).

Table 3: Nutritional status of children using MUAC-for-age as an index with WHO Child Growth Standards (2006)

	Boys			Girls			Total (boys + girls)		
Age (years)	**n**	**<-2SD**	**%**	**n**	**<-2SD**	**%**	**N**	**<-2SD**	**%**

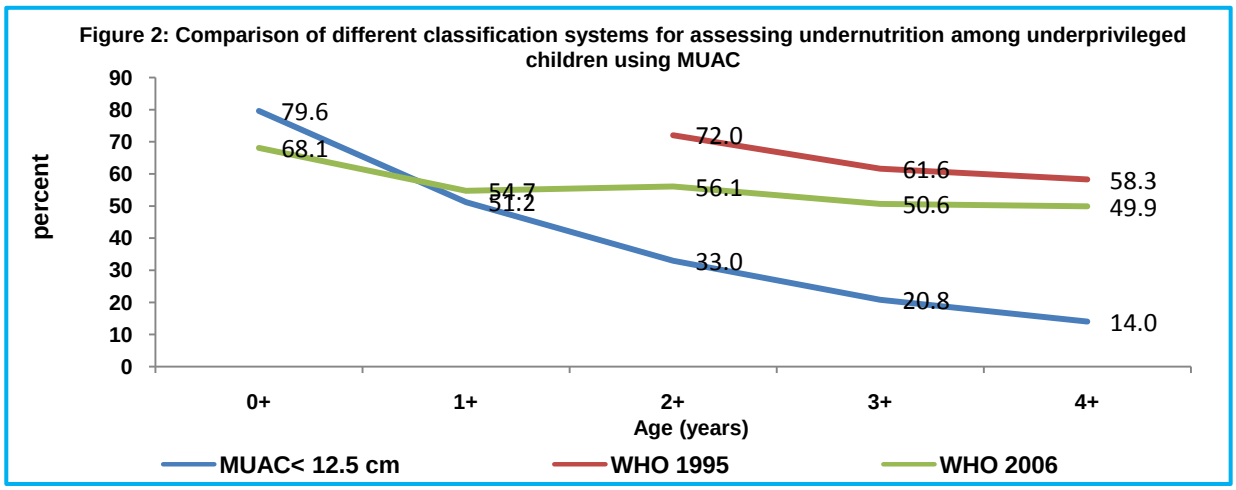
0+	146	108	74.0	136	84	61.8	282	192	68.1
1+	406	261	64.3	453	209	46.1	859	470	54.7
2+	488	295	60.5	502	260	51.8	990	555	56.1
3+	463	249	53.8	570	274	48.1	1033	523	50.6
4+	426	207	48.6	456	233	51.1	882	440	49.9
All	1929	1120	58.1	2117	1060	50.1	4046	2180	53.9

Comparison of prevalence of undernutrition using MUAC with other classification

Table 4: Assessment of undernutrition in children using MUAC (n=4046)

	MUAC< 12.5 cm	WHO 2006 (<-2SD)	WHO 1995 (<-2SD)
Boys	31.5	58.1	68.6
Girls	31.2	50.1	59.8
All	32.6	53.9	64

Most of the studies conducted on Indian children had used either single cut-off classification or WHO 1995 MUAC-for-age classification, therefore for comparison, analysis has also been done with these two classification systems (Table 4).



It was observed that single cut-off classification (MUAC<12.5 cm) underestimated the rates of undernutrition (32.6 %) as compared with WHO child growth standards (2006) in 3-60 months old children. Agewise prevalence of undernutrition clearly showed that single cut-off classification overestimated rates of undernutrition in children of 6-12 months of age group (Figure 2), and after that it underestimated the rates of undernutrition as compared with WHO child growth standards (2006). These results were comparable to those obtained fromchildren residing in Punjab (38.5%, Kaur et al, 2005),Kolkatta(28.6%, Chatterjee and Saha, 2008)and Orissa (36 %, Chakarbarthy et al, 2008). However, a study conducted on 9-36 months old children residing in east Delhi showed much higher rates of undernutrition (73 %, MUAC< 12.5 cm).

WHO 1995 (based on US children) overestimated the prevalence of undernutrition in 2-5 year oldchildren as compared to WHO Child Growth standards (2006). In the present study, about 64 % of children were identified as undernourished using WHO 1995 classification for MUAC-for-age (Table 4). The findings were consistent with the rates of undernutrition in 2-5 year old children (64.5 %) living in rural areas of West Bengal (Mandal and Bose 2009).

All age-gender combined prevalence of severe undernutrition (<-3SD MUACZ) was 11.2 % in the present study which is comparable to 1-5 year old children (17%) living in Silchur district of Assam (Shareefand Manoj, 2016) and much higher than 3-5 year old children residing in West Bengal (3.7%, Biswas et, al., 2010). In comparison, the number of children with severe acute malnutrition in the present study, with single cut-off point (MUAC <11.5) cm was slightly higher (13.1 %).

IV. CONCLUSION

The combined age-sex prevalence of undernutrition among young underprivileged children living in a slum of Delhi was much higher as assessed by MUACZ as compared to Weight-for-height index. The fixed cut-off point for MUAC makes it relatively simple index, but it ignores age related changes. Currently available evidences indicate that MUAC is the best in terms of ease, age independence, precision, accuracy, sensitivity and specificity andscreening for severe malnutrition (Joseph, 2002; Bobby,

2002; Briend and Zimicki, 1986). MUAC can be measured by minimally trained health workers and is a reliable indicator of acute nutrition.In the present study, the age and sex independent classification for 6-59 months, overestimated undernutrition in younger age groups (0-1 years) and underestimated in older age groups (1-5 years). The WHO, 1995 Classification was based on <-2SD cut-offs of US based children, which overestimated the burden of undernutrition among children at all ages as compared to age and sex related WHO Child Growth Standards (2006) values. However, more scientific evidence is required for validity of MUAC-for-age to be used as an indicator for assessing acute undernutrition among young children.

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