Original Research Article

Role of Mid Arm Muscular Area (MAMA) in identification of Severe Acute Malnutrition

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Abstract

Background: Mid arm muscular area (MAMA) and triceps skin fold thickness (TSFT) were introduced for the body composition and nutritional status assessment. Currently these parameters in the identification of Severe Acute Malnutrition (SAM) are unutilized. This study compared age specific upper arm composition and nutritional status among children with normal nutrition and Severe Acute Malnutrition (SAM). **Method:** This case control study was conducted in Special Malnutrition Treatment Unit (S.M.T.U.) and children medical wards of a medical college hospital in Madhya Pradesh. In the age group of 6-to-59 month, 100 children with SAM and 100 normal nutritional status children as control were taken. Mid upper arm circumference (MUAC) was measured by nonflexible colour coded tape and TSFT by Harpenden skin fold calliper to calculate MAMA by formula, MAMA = (MuAC – π×TSFT)^2/4π. **Result:** Mean MAMA, mean MUAC and mean TSFT are more among controls as compared to case (p<0.001). In normal nutritional status children MUAC, MAMA and TSFT increases as the age advances, unlike in SAM children where MUAC, TSFT and MAMA were almost stationary. MAMA and MUAC are significantly correlated (p<0.001). TSFT was significantly correlated with MAMA and MUAC. Each unit change in TSFT i.e., with 1 cm increase in TSFT, severity of malnutrition (z score decreased by 10.3) decreased significantly [z score = 7.47 – 10.31 (TSFT)]. Similarly, with each cm^2 increase in MAMA, the severity of malnutrition decreased i.e., z score decreased by 0.52 which was statistically significant [z score = 8.81 – 0.52 (MAMA)]**Conclusion:** The upper-arm composition can be a useful measure for the nutritional status assessment in SAM children. The MAMA is a valuable parameter that can be used to measure specifically the muscle-mass. The use of MAMA can improve the accuracy of assessment in oedematous SAM and hence seems to be a more appropriate tool in a health care setting

Keywords: Mid Arm Muscular Area, Severe Acute Malnutrition, Triceps Skin Fold Thickness.

Introduction

Worldwide, severe acute malnutrition (SAM) affects about 16.4 million children under 5 at any time and kills over half a million annually [1]. Prevalence of SAM is high in our country 7.5% and more in the state of Madhya Pradesh 9.2% as per NFHS-4 survey.

Diagnosis of SAM depends on anthropometry and among anthropometric parameters evaluation of upper limb has become useful indicator of nutritional status of children. In the total arm area bone diameter remains constant, the muscle mass and subcutaneous fat changes leads to difference in measurement. As it is evident that Weight for height z score and arm circumference can not differentiate between the muscular and or fatty body. Mid upper arm circumference (MUAC) is commonly used as an age independent criterion, measures the total arm area and does not measures muscle wasting and muscle mass alone. Rather it also measures subcutaneous fat. Triceps skin fold measures the fat reserve, and tricipital skin fold keeps on changing [2]. So that there is a need of anthropometric parameter which can measures muscle mass. Mid Arm Muscle Area (MAMA) represents relative contribution of fat and muscle to the total arm area. Thus, measurement of MAMA is better indicator of fat and protein reserve than tricipital skin fold and arm circumference. Though currently MUAC is the most used age independent criteria for identification of SAM, but the specificity of measuring muscle mass associated with MAMA makes it a worthy contender as an identification parameter of SAM.This study was done for estimation of MAMA and its correlation with MUAC and TSFT in SAM and normal nutritional status children and determine its utility in detection of SAM.

Material and Methods

This case control study was conducted in Special Malnutrition Treatment Unit (S.M.T.U.) and children medical wards in a medical college hospital of M.P. A total of 100 SAM children and 100 normal nutritional status children in the age group of 6 to 59 months were enrolled after written informed parental consent and clearance from institutional ethical committee. Children below 6 months of age with Severe acute malnourished were excluded from the study. On admission Weight, Height/ length, Head circumference, Chest circumference were recorded. MUAC was measured by using color coded non-stretchable measuring tape i.e., MUAC tape. TSFT was Measured by using Harpenden skinfold calliper and MAMA is Calculated by the formula -MAMA = (MUAC – π × TSF)^2/4π

Results

In normal nutritional status children MUAC and MAMA increased as the age advanced unlike in SAM children where MUAC, TSFT and MAMA were almost stationary. Mean MAMA, mean MUAC and mean TSFT are more among controls as compared to case (p<0.001) (Table1). Mean MAMA±SD in male is 10.16±3.03 and in female 10.30±2.68(Table 2). MAMA and MUAC are significantly correlated (p<0.001) (Fig. 1). TSFT is significantly correlated with MAMA and MUAC**.** Each unit change in TSFT i.e., with 1 cm increase in TSFT, severity of malnutrition decreases i.e., z score

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decreases by 10.3 which is statistically significant. (z score = 7.47 – 10.31 (TSFT). Similarly, with each cm^2 increase in MAMA, the severity of malnutrition decreases i.e., z score decreases by 0.52 which is statistically significant. (z score = 8.81 – 0.52 (MAMA) (**Table 3)**. This shows that MUAC is affected by both MAMA and TSFT.

Table 1: Anthropometric parameters and age group among case and control

Age Group	Case						Control					
	MUAC		TSF		MAMA		MUAC		TSF		MAMA	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
6-11 months	10.29	1.11	.23	.04	7.40	1.55	13.59	.42	.45	.04	11.83	.68
12-23 months	10.02	.68	.30	.04	8.13	.97	14.18	.55	.49	.05	12.73	.96
24-35 months	10.71	.67	.33	.05	7.47	1.02	15.16	.62	.56	.07	14.29	1.08
36-47 months	10.67	1.01	.32	.10	7.49	1.07	15.40	.63	.68	.12	14.05	1.69
48-60 months	11.38	.19	.38	.05	8.27	.16	15.62	1.14	.72	.06	14.29	2.14

Table 2: Gender wise distribution of anthropometric parameters

Anthropometric parameters	Sex of child	N	Mean	Std. Deviation
Mid upper arm circumference	Female	98	12.4969	1.90179
	Male	102	12.3941	2.11219
Triceps skin fold	Female	98	.38799	.145669
	Male	102	.39232	.135700
Mama	Female	98	10.3066	2.68540
	Male	102	10.1574	3.03830

Table 3: Correlation of MAMA, MUAC and Triceps skin fold thickness among case and control

Anthropometric Variable 1	Anthropometric Variable 2	r (Pearson correlation coefficient)	P value
Case			
MAMA	MUAC	0.97	<0.001
MAMA	TSF	0.28	0.005
MUAC	TSF	0.48	<0.001
Control			
MAMA	MUAC	0.96	<0.001
MAMA	TSF	0.59	<0.001
MUAC	TSF	0.78	<0.001

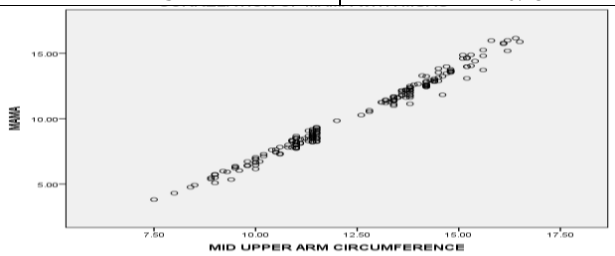

Fig. 1: Correlation of MAMA with MUAC

Table 4: Linear Regression Analysis with respect to severity of Malnutrition (Z score)

Independent Anthropometric Variable	Constant (B)	A Standardised Coefficient (A)	P Value	95% Confidence Interval
MUAC	12.92	-0.76	<0.001	-0.82 to -0.70
Triceps Skin Fold Thickness	7.47	-10.31	<0.001	-11.34 to -9.28
MAMA	8.81	-0.52	<0.001	-0.57 to -0.48

Discussion

Upper-arm anthropometry is a valuable assessment of the nutritional status. The upper-arm composition can provide a better assessment of muscularity and adiposity, long term assessment of the body composition. Mid-arm muscular area (MAMA) is a valuable index used to identify the risk factor of malnutrition when muscle-mass is decreased. O Yaw Addo et al in 2017 done a study on assessment of anthropometric measures, observed that MUAC together with the triceps skinfold thickness (TSFT) can be used to estimate skeletal muscle mass and subcutaneous fat stores. [3] Similar to this study in which both MUAC and TSFT are significantly correlated with MAMA.In present study as the age increases, mean MUAC, mean TSFT and mean MAMA increases. In a study done by Gundega Lipsberga, there was no statistically significant correlation between age and TSFT both in boys and girls. In boys there was a medium correlation between age and MAMA (r=0.33; p<0.05) and age. However, in girls there was no statistically significant correlation [4]. There was also no statistically significant correlation between age and TSFT in boys and girls. In contrary to this, present study showed that there was significant positive correlation of MUAC (r=0.226; p<0.001) with age, same as in TSFT thickness (0.424; p<0.001) which was also significantly positively correlated with age. MAMA (r=0.18; p<0.001) is also significantly positively correlated with age. Mean weight, height and MUAC was gradually increases with ages (p<0.01). The age and sex specific mean TSFT did not show any age-specific trends, but the proportions are significantly greater among female than male (p<0.05) in a study done by Jaswant S. et al [5] in 2014 with sample size of 1545. Age and sex-specific muscularity were found significantly greater among boys than girls (p<0.01), while adiposity was significantly greater among girls (p<0.01). The

overall prevalence of low and below-average UAMAH was found to be 16.38% and 22.65% respectively. The overall prevalence of thinness was 23.69% (26.36% boys, 21.03% girls) (p>0.05). And they concluded that the combination of upper-arm composition and conventional anthropometric measures appear to be useful for body composition and nutritional status assessment. Similar to our study in which there was increase in mean weight, height, MUAC and muscular area as the age increases, which is statistically significant (p value<0.001). And the TSF also has significant positive correlation with the age (p value<0.001).Frisancho AR et al studied 9,134 children ranging in age from 2 to 17 years. Means and percentiles of upper arm muscle area were calculated for 3 cm increments in stature from 84 to 184 cm for boys and from 84 to 176 cm for girls. It was observed that prepubescent female having same height likely to have same upper arm muscle area as male, TSF and MUAC do not estimate the magnitude of the tissue changes in the upper arm [6]. It was similar to our study in which there is almost same MAMA in male and female and our study resulted mean MAMA±SD in male is 10.16±3.03 and in female 10.30±2.68.Kankana De in 2017 observed that mid arm circumference, upper arm area is increased by age in one way ANOVA. F=193.45 which showed significant relation in frequency of upper arm muscle area and MUAC with age and they concluded female were more malnourished contrary to our study that shows both sexes have same prevalence of malnutrition [7].Girmay Medhin et al in their prospective study on child malnutrition in low-income countries, a population-based sample Significant and consistent predictors of infant undernutrition in both logistic and linear multiple regression models were male gender. But prevalence of malnutrition in male and female remains almost same in this study [8].Gurney and Jelliffee found that cross sectional arm areas represent better estimates of the relative contribution of fat and muscle to the total arm area than mid upper arm circumference (MUAC). TSF and MUAC do not estimate the magnitude of the tissue changes in the upper arm. This may be due to the fact that for a given thickness of subcutaneous fat it takes more fat to cover a large limb than it does to cover a smaller limb. This is particularly important during infancy when there is around fourfold increase in body fat store. MAMA helps to estimate nutritional status of children other than MUAC as it specifically measures the muscle mass. By estimating nutritional status, it shows present scenario of undernutrition [9].Saito R et al in their study on validity of mid-arm muscular area measured by anthropometry in nonobese patients with increased muscle atrophy and variation of subcutaneous fat thickness, concluded that muscle deformity indexes were positively correlated with age in males (r=0.47, P<0.05) and females (r=0.66, P<0.001). SFVI was positively correlated with age only in females (r=0.54, P<0.01). Even in these patients, the relative MAMA estimated by anthropometry was significantly associated with that measured by CT (r=0.85, P<0.0001 in male and r=0.90, P<0.0001 in female). They concluded that mid-arm muscular area estimated by anthropometry was a reliable indicator of muscle mass in patients with muscle atrophy and varying thickness of subcutaneous fat in lean patients [10]. Similar results were obtained by our study, there is significant positive correlation exists between MAMA and age of subjects i.e. Pearson correlation coefficient, (r value=0.180) which was statistically significant (p value<0.001). Along with this subcutaneous fat thickness (TSF) was also significantly positively correlated with age, (r value=0.424, p value<0.001).Sirinuch Chomtho et al in 2006 done a study on arm anthropometry for pediatric body composition in 110 healthy children and 49 cystic fibrosis patients where they measured body weight, MUAC and triceps skin fold thickness, and calculated arm muscle area and arm fat area. They observed that the girls had significantly more total body and arm FM than boys. Girls also had significantly higher MUAC, TS, AMA, and AFA than boys. In cystic fibrosis patients there was no significant gender difference in age [11]. Sutanu Dutta Chowdhury et al in their study of upper arm muscle and fat area, an evaluated nutritional status by determining the growth pattern of upper arm muscle area (UAMA), upper arm fat area (UAFA) and upper arm muscle area by height (UAMAH) of 890 (473 boys and 417 girls) aged 5–12 years, calculating from mid-upper arm circumference and triceps skinfold. And they made growth curves of UAFA-for-age and UAMA by height for boys and girls. They concluded that the curves of UAFA-for-age and UAMA by height are good indicators of nutritional status in children. UAMA and UAFA may not be similarly affected in undernourished children of every community .

Conclusion

The upper-arm composition can be a useful measure for the nutritional status assessment in SAM children The MAMA is a valuable index used to identify risk factors with chronic malnutrition where muscle mass is depleted. MAMA is more strongly related to muscle-mass rather than to adiposity pattern. The use of MAMA can improve the accuracy of assessment in oedematous SAM and hence seems to be a more appropriate tool in a health care setting.

Conflict of Interest: Nil Source of support:Nil

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