Original Research Article

Utilization and practicability of using Mid-upper Arm Circumference alone as an admission and discharge criterion in Nutritional Rehabilitation Programmes

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Received: 21-08-2021 / Revised: 05-09-2021 / Accepted: 10-10-2021

Abstract

Background: World Health Organization (WHO) recommends the using weight-for height Z-score (WHZ) < -3 SD and/or mid-upper arm circumference (MUAC) < 115 mm as anthropometric criteria for admission to therapeutic feeding programs. There is a need for more information on the programmatic implications of using MUAC alone as a standalone admission criterion in nutrition programming. **Aims and Objectives:** To rule out difference between MUAC and weight-height criteria and to establish effectiveness of MUAC as single criteria for identification, follow-up and discharge of malnourished children. **Methods:** The children aged 6 to 59 months admitted in a nutritional rehabilitation centre were included in the study. Data on demographic details, chief complains, anthropometric measurements, height/ length, weight and MUAC were recorded at the time of admission. Anthropometric measurements, height/ length, weight and MUAC were recorded on discharge and during first two follow up visits conducted on 15 and 30 days after discharge. **Results:** The sensitivity of MUAC was 62.4%, specificity was 60.0%, Positive predictive value (PPV) was 97.5% and negative predictive value (NPV) was 6.0% at the time of admission. The sensitivity of MUAC was 58.4%, specificity was 83.3%, PPV was 97.1% and NPV was 16.9% at the time of discharge. On admission, of 260 children, MUAC (<11.5cm) was able to identify 61.54% whereas WHZ score (<-3SD) was able to identify 96.15% severely malnourished children. **Conclusion:** MUAC is good at identifying undernourished children but the MUAC is not good to rule out under nutrition at time of admission and discharge.

Keywords: Under nutrition, malnourish, mid upper arm circumference, screening

Introduction

Each year, severe acute malnutrition (SAM) affects 34 million children under the age of 5 years, globally[1]. It is associated with significantly increased risks of mortality and morbidity[1]. Forty-four and 39.2% under 5 year children are undernourished in India and Gujarat, respectively[2]. In 2007, a joint United Nations statement endorsed a new model for the management of SAM that combines outpatient treatment with ready-to-use therapeutic foods (RUTF) for uncomplicated cases and inpatient treatment for complicated cases[3]. This model has been established to be both effective and cost-effective, with the potential to bring life-saving treatment to millions of children[4].

Since 2009, the World Health Organization (WHO) has recommended using weight-for height Z-score (WHZ) < -3 SD and/or mid-upper arm circumference (MUAC) < 115 mm as anthropometric criteria for admission to therapeutic feeding programs[5]. In recent years, however, the use of MUAC alone as an indication for admission has been increasingly debated[6]. MUAC is predictive of death, easy to use, acceptable, and linked to community-based screening methods[7]. MUAC and WHZ select different children for treatment therapeutic feeding programs[8] that can lead to an alteration in programs which currently admit the children using MUAC < 115 mm and/or WHZ score < -3 SD to a new model admitting the children using MUAC < 115 mm only. Depending upon the context, up to 63–79% of children currently recommended for therapeutic feeding with current guidelines would not become eligible if MUAC < 115 mm alone is used for admission[9]. To use MUAC as a standalone admission criterion in nutrition programming, there is a need for more information on the programmatic implications of using MUAC alone. The demographic and anthropometric differences among children are identified by WHZ and MUAC in initial reports. MUAC is more likely to identify children that are younger, female and more stunted[10]. Thus, MUAC identifies the children more vulnerable or at a higher risk of death, supporting the change to a MUAC-only admission criterion. Published evidence is, however, scarce and limited in breadth, due to the narrow scope of routine program data often available for analysis particularly in Indian settings. Important parameters, including the clinical profile and treatment response, of children who are currently eligible for therapeutic feeding by dual indicators in comparison to MUAC alone criterion remain poorly documented. So, the present study was designed to identify the effectiveness of mid upper arm circumference as a single criterion for identification, follow up and discharge of malnourished children.

Aims and objectives

1. To rule out difference between mid-upper arm circumference and weight-height in the identification, follow-up and discharge of malnourished children.
2. To establish effectiveness of mid upper arm circumference as single criteria for identification, follow-up and discharge of malnourished children.

Methodology

A prospective study was conducted in a nutritional rehabilitation

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centre of a tertiary care hospital, Surat after approval from the Institutional Ethics Committee. A total of 260 children aged 6 to 59 months admitted in a nutritional rehabilitation centre from July 2015 to October 2016 were included in the study if they had WHZ score < -2 SD, MUAC < 11.5cm, bilateral pedal edema and visible severe wasting. The children with definite pathological conditions or disability which can impact the normal growth were excluded from the study. The consent was obtained from the parents for each participating child in the study. Data on demographic details, chief complains, anthropometric measurements, height/ length, weight and MUAC were recorded at the time of admission. All the children were given treatment as per routine protocol.

Anthropometric measurements, height/ length, weight and MUAC were recorded on discharge and during first two follow up visits conducted after 15 and 30 days after discharge. Weight was measured using a standardized digital weighing machine with accuracy of ± 10 g. For children < 2 years age, length was measured using a length board with fixed head board and movable foot piece whereas for children > 2 years of age, height was measured using a stadiometer with a vertical back board, a fixed base board, and a movable head board. Both length and height were measured with a straight posture of a child. WHZ score was noted using a weight for height reference table and categorized into different categories. Children with WHZ score < -3 SD was considered as severe acute malnourished children. MUAC was measured using a color coded MUAC tape at the midpoint between the end of the shoulder (acromion process) and the tip of the elbow (olecranon process). The green colour of the MUAC tape (> 12.5 cm) indicates a normal child; yellow colour (11.5 – 12.5 cm) indicates moderate acute malnutrition and red colour (< 11.5 cm) indicates severe acute malnutrition.

Statistical Analysis: Data entry was done in Microsoft excel software. Children were categorized using weight for height z score <-3sd and MUAC. Taking WH z score as the gold standard the sensitivity, specificity, positive predictive value, negative predictive value, of single MUAC cutoff <11.5cm were estimated at admission, discharge and follow up.

Ethical Consideration: Ethical approval was taken before the commencement of the study from the Institutional Ethical Committee.

Results

The present study was conducted among 260 children to assess usefulness of Mid Upper Arm Circumference (MUAC) for identification, follow-up and discharge of malnourished children enrolled in nutritional rehabilitation centre. Demographic details of enrolled children are shown in table 1. Table 2 shows average height, weight and MUAC of children at admission, discharge and follows up.

Table 1: Demographic detail of study participants

Variable	Number of Children (n =260)	Percentage
Age group (Months)		
6-11	72	27.7
12-23	96	36.9
24-35	46	17.7
36-47	24	9.2
48-59	22	8.5
Sex		
Male	127	48.8
Female	133	51.2
Socio- economic status		
Upper middle	1	0.4
Middle	85	32.7
Lower middle	66	25.4
Lower	108	41.5
Presenting complains		
Acute gastro enteritis	81	31.2
Anemia	29	11.2
Fever	36	13.8
Upper respiratory tract infection	62	23.8
Lower respiratory tract infection	52	20

Table 2: Comparison of height, weight and MUAC at admission, discharge and follow-ups

Anthropometric (Mean ± SD)	At the time of Admission (n=260)	At discharge (n= 260)	At first follow-up (n=221)	At Second follow-up (n=217)
Height (cm)	71.5 ± 9.55	71.48 ± 9.63	71.22 ± 9.56	71.37 ± 9.66
Weight (kg)	6.23 ± 1.69	6.55 ± 1.74	6.66 ± 1.67	6.84 ± 1.68
MUAC (cm)	10.77 ± 1.12	10.99 ± 1.11	11.19 ± 1.06	11.39 ± 1.05

Table 3: Validation of MUAC to identify Under nourished compare to Z score at the time of admission

MUAC (cm) at the time of Admission	Z score at the time of Admission		Total
	<-3SD	<-2SD	
<11.5	156	4	160
≥11.5	94	6	100
Total	250	10	260

Sensitivity	62.4%
Specificity	60.0%
Positive Predictive Value (PPV)	97.5%
Negative predictive value (NPV)	6.0%

The above table shows comparison of MUAC and weight for height Z score at the time of admission. The sensitivity of MUAC was 62.4%, specificity was 60.0%, Positive predictive value was 97.5% and negative predictive value was 6.0% at the time of admission. In this study high PPV indicates that the MUAC is good at identifying undernourished children, however low NPV indicate that the MUAC is not good to rule out under nutrition.

Table 4: Validation of MUAC to identify under nourished compare to Z score at the time of discharge

MUAC (cm) at Discharge	Z score at first Discharge		Total
	<-3SD	<-2SD	
<11.5	138	4	142
≥11.5	98	20	118
Total	236	24	260

Sensitivity	58.4%
Specificity	83.3%
Positive Predictive Value	97.1%
Negative predictive value	16.9%

The above table shows comparison of MUAC and weight for height Z score at the time of discharge. Based on this table, the sensitivity of MUAC was 58.4%, specificity was 83.3%, Positive predictive value was 97.1% and negative predictive value was 16.9% at the time of discharge. In this study high PPV indicates that the MUAC is good at identifying undernourished children, however low NPV indicate that the MUAC is not good to rule out under nutrition.

Table 5: Comparison of MUAC and WHZ score criteria on admission, at discharge and further follow ups

	On Admission	On Discharge	First Follow up	Second Follow up
n	260	260	221	217
MUAC <11.5 cm	160 (61.54)	142 (54.62)	112 (50.68)	92 (42.4)
WHZ score <-3SD	250 (96.15)	236 (90.77)	174 (78.73)	115 (52.9)
Combined (WHZ <-3SD and MUAC <11.5cm)	142 (54.62)	133 (51.15)	101 (45.7)	84 (38.71)

Table 5 shows comparison of screening criteria for severely acute malnourished children using different criteria like MUAC <11.5 cm, WHZ score <-3SD and combination of both. On admission proportion of children having MUAC <11.5 cm were 61.54%, WHZ score <-3SD were 96.15% and having fulfilled both criteria were 54.62%. On discharge proportion of children having MUAC <11.5 cm were 54.62%, WHZ score <-3SD were 90.77% and having fulfilled both criteria were 51.15%. On first follow up proportion of children having MUAC <11.5 cm were 50.68%, WHZ score <-3SD were 78.73% and having fulfilled both criteria were 45.7%. On second follow up proportion of children having MUAC <11.5 cm were 42.4%, WHZ score <-3SD were 52.9% and having fulfilled both criteria were 38.71%.

Discussion

The present study was conducted among 260 children to assess usefulness of Mid Upper Arm Circumference (MUAC) for identification, follow-up and discharge of malnourished children enrolled in nutritional rehabilitation centre.

In this study high PPV indicates that the MUAC is good at identifying undernourished children, however low NPV indicate that the MUAC is not good to rule out under nutrition. Myatt *et al*. reviewed various indicators for case detection in the context of SAM[11]. The authors scored various indicators on the basis of a set of properties and concluded MUAC<11 cm or the presence of bipedal oedema was the most appropriate screening criterion. Defourny *et al*. evaluated the use of MUAC<11.0 cm as an admission criterion in Niger[12]. More broadly, MUAC has been proposed as a single admission criterion for several reasons, including its simplicity of use and correlation with increased risk of death. It is recognized that MUAC is more easily implemented than WHZ in field-based settings and facilitates community-based screening.

In this study high PPV indicates that the MUAC is good at identifying undernourished children, however low NPV indicate that the MUAC is not good to rule out under nutrition. The study by Binns PJ et al[13] confirms that a discharge criterion of MUAC greater than 12.5 cm for two consecutive visits represents a practicable and safe discharge criterion according to the standard established for the study and is also an appropriate discharge criterion for children with a height of less than 65 cm at admission. This suggests that MUAC≥12.5 cm for two consecutive visits is as at least safe as discharge using WHZ>− 1 z-scores. The rate of relapse and mortality following discharge as 'cured' reported in this study are also similar or lower to those reported by Ashworth in other studies using weight for height (e.g. WHZ>−1 or weight-for-height percentage of median>85 %) as the discharge criterion from CMAM programmes[14].

The decision regarding the use of WHZ *v*. MUAC for admission to therapeutic feeding is complicated by the fact that each measure may select different children for treatment. Depending on the setting and geographic location, 40–90 % of children are not classified as severely malnourished based on both criteria[9,11,15,16]. Existing literature suggests that MUAC-based programmes tend to identify significantly more girls and younger children than those identified by WHZ.Receiver-operating characteristic curves have also demonstrated that MUAC may identify children at a higher risk of mortality[17]. Grellety E at el[10] also confirm these findings. Grellety E at el[10] found that a MUAC cut-off of <11.5 cm would have excluded 33 % of the children who died in the programme, whereas a WHZ cut-off of <−3 identified almost all (98 %) children who died. This finding is in contrast with community studies in which low WHZ is less predictive of mortality than low MUAC[7,11]. In Burkina Faso in 2007–2009, children were admitted with MUAC ≤11.8 cm or oedema, suggests children with MUAC of 11.6–11.8 cm benefited from treatment, as evidenced by rates of weight gain similar to those typically seen[18]Fernandez et al, using data from 39 surveys in 10 mostly African countries, showed that a MUAC,135 mm, was optimal to identify SAM (highest AUC in ROC curve), with a sensitivity of 84.5%[9]. Briend et al showed that both MUAC 11.5 cm and WHZ <-3SD carry a great risk for death[7]. The authors argue that there is no benefit of using WHZ in addition to MUAC as specificity of MUAC is higher than of WHZ to predict subsequent health. But as shown in our data, MUAC 11.5 mm and WHZ clearly identify a distinctly different set of children with malnutrition, with hardly any overlap between the 2 indicators.Present study found sensitivity of 62.4% and specificity of 60.0%. Similar result was found in a study by Goossens S et al[18] in 2012 where sensitivity was 38.54% and specificity was 43.66%. Sensitivity and specificity of MUAC was varied widely in various study. Fiorentino M et al in 2016 found sensitivity of 8.6% and specificity of 54% while A study by Dairo et al in 2012 found sensitivity of 20% and specificity of 95.3%. In these both study specificity was very good compare to the present study, however the sensitivity of the present study was good compare to these two above stated studies.

MUAC has been considered a valid and simple screening tool to identify SAM in children under 5 years of age. In our data set however, MUAC, 11.5 cm identified very few children with WHZ <-2SD. This means that with the current guidelines of WHO, which were updated in 2013, using only MUAC,115 mm at community level to screen for SAM, large number of children with a under nutrition are missed and left without treatment. Additional studies may be needed to assess whether a admission discharge criterion of MUAC≥12.5 cm is safe in other SAM programs with low levels of supervision and in other settings. There are currently no internationally agreed standards by which to assess the safety of MUAC or other discharge criteria.

Conclusion

Here we conclude that the MUAC is good at identifying undernourished children but the MUAC is not good to rule out under nutrition at time of admission and discharge. This is actually not surprising, as they each measure different aspects of body composition, reflecting perhaps different categories of malnutrition. Therefore, we propose that both indicators should be regarded as independent from each other, and cannot be used as substitutes for each other.

References

1. UNICEF/Coverage Monitoring Network/ACF International. The State of Global SAM Management Coverage 2012. New York & London: UNICEF/Coverage Monitoring Network/ACF International, 2012.
2. National Family Health Survey 4, India. Available on http://rchiips.org/nfhs/nfhs4.shtml Accessed on 2nd Dec 2016
3. WHO, WFP, UNSCN, UNICEF. Joint Statement on Community-Based Management of Severe Acute Malnutrition. Available: http://www.who.int/maternal_ child_adolescent/ documents / a91065/en/ Accessed 2nd March 2016.
4. Puett C, Sadler K, Alderman H, Coates J, Fiedler JL, Myatt M. Cost-effectiveness of the community based management of severe acute malnutrition by community health workers in southern Bangladesh. Health policy and planning. 2013; 28(4):386–99.
5. World Health Organization, UNICEF. WHO child growth standards and the identification of severe acute malnutrition in infants and children. Geneva: World Health Organization, 2009.
6. Ali E, Zachariah R, Shams Z, Vernaeve L, Alders P, Salio F, et al. Is mid-upper arm circumference alone sufficient for deciding admission to a nutritional programme for childhood severe acute malnutrition in Bangladesh? Transactions of the Royal Society of Tropical Medicine and Hygiene. 2013; 107 (5):319–23.
7. Briend A, Maire B, Fontaine O, Garenne M. Mid-upper arm circumference and weight-for-height to identify high-risk malnourished under-five children. Maternal & child nutrition. 2012; 8(1):130–3
8. Laillou A, Prak S, de Groot R, Whitney S, Conkle J, Horton L, et al. Optimal screening of children with acute malnutrition requires a change in current WHO guidelines as MUAC and WHZ identify different patient groups. PloS one. 2014; 9(7):e1 01159.
9. Fernandez MA, Delchevalerie P, Van Herp M. Accuracy of MUAC in the detection of severe wasting with the new WHO growth standards. Pediatrics. 2010; 126(1):e195–201.
10. Grellety, E., Krause, L.K., Shams Eldin, M., Porten, K. and Isanaka, S. 'Comparison of weight-forheight and mid-upper arm circumference (MUAC) in a therapeutic feeding programme in South Sudan: is MUAC alone a sufficient criterion for admission of children at high risk of mortality?', Public Health Nutrition, 2015;18(14), pp. 2575–2581.
11. Myatt M, Duffield A, Seal A et al. (2009) The effect of body shape on weight-for-height and mid-upper arm circumference based case definitions of acute malnutrition in Ethiopian children. Ann Hum Biol 36, 5–20.
12. Defourny I, Minetti A, Harczi G et al. (2009) A large-scale distribution of milk-based fortified spreads: evidence for a new approach in regions with high burden of acute malnutrition. PLoS One 4, e5455
13. Binns PJ, Dale NM, Banda T, Banda C, Shaba B, Myatt M. Safety and practicability of using mid-upper arm circumference as a discharge criterion in community based management of severe acute malnutrition in children aged 6 to 59 months programmes. Archives of Public Health. 2016;74(1):24.
14. Collins S, Sadler K, Dent N, Khara T, Guerrero S, Myatt M, et al. Key issues in the success of community-based management of severe malnutrition. Food Nutrition Bulletin-United Nations University - 2006;27:S49.
15. Berkley J, Mwangi I, Griffiths K et al. Assessment of severe malnutrition among hospitalized children in rural Kenya: comparison of weight for height and mid upper arm circumference. JAMA .2005;294, 591–597.
16. Roberfroid D, Hammami N, Lachat C, Weise Prinzo Z, Sibson V, Guesdon B, Goosens S, Kolsteren P. Utilization of Mid-upper Arm Circumference Versus Weight-for-Height in Nutritional Rehabilitation Programmes: a Systematic Review of Evidence. Geneva: World Health Organization; 2013
17. WHO Multicentre Growth Reference Study Group (2009) WHO Child Growth Standards: Methods and Development. Growth Velocity Based on Weight, Length and Head Circumference. Geneva: WHO.
18. Goossens S, Bekele Y, Yun O, Harczi G, Ouannes M, Shepherd S. Mid-upper arm circumference based nutrition programming: evidence for a new approach in regions with high burden of acute malnutrition. PLoS One 2012;7:e49320.

Conflict of Interest: Nil Source of support: Nil