Is mid-upper arm circumference alone sufficient for deciding admission to a nutritional programme for childhood severe acute malnutrition in Bangladesh?

Engy Ali[a], Rony Zachariah[a], Zubair Shams[b], Lieven Vernaeve[b], Petra Alders[c], Flavio Salio[b], Marcel Manzi[a], Malik Allaouna[c], Bertrand Draguez[c], Pascale Delchevalerie[c] and Anthony D. Harries[d,e]

[a]Médecins Sans Frontières, Medical Department (Operational Research), Brussels, Belgium; Médecins Sans Frontières Luxembourg, 68 Rue de Gasperich, L-1617 Luxembourg, Luxembourg; [b]Médecins Sans Frontières, Kamrangirchar, Dhaka, Bangladesh; [c]Médecins Sans Frontières, Brussels Operational Centre, Brussels, Belgium; [d]International Union against Tuberculosis and Lung disease, Paris, France; [e]London School of Hygiene & Tropical Medicine, London, UK

Corresponding author: Tel: + 352 332 522; Fax: + 352 335 133; E-mail: engy.y.ali@gmail.com

Objectives: Mid-upper arm circumference (MUAC) and weight-for-height Z-score (WHZ) identify different populations of children with severe acute malnutrition (SAM) with only some degree of overlap. In an urban slum in Bangladesh, we conducted a prospective cohort study on children assessed as being severely malnourished by WHZ (<-3) but not by MUAC (>115 mm), to: 1. Assess their nutritional outcomes, and 2. Report on morbidity and mortality.

Methods: Children underwent 2-weekly prospective follow-up home visits for 3 months and their anthropometric evolution, morbidity and mortality were monitored.

Results: Of 158 children, 21 did not complete follow-up (six were lost to follow-up and 15 changed residence). Of the remaining 137 children, nine (7%) required admission to the nutrition programme because of: MUAC dropping to <115 mm (5/9 children), weight loss $\geq 10\%$ (1/9 children) and severe medical complications (3/9 children, of whom one died). Of the remaining 128 children who completed follow-up, 91 (66%) improved in nutritional status while 37 (27%) maintained a WHZ of <-3. Cough was less frequent among those whose nutritional status improved.

Conclusions: It seems acceptable to rely on MUAC as a single assessment tool for case finding and for admission of children with SAM to nutritional programmes.

Keywords: Mid-upper arm circumference, Weight-for-height Z-score, Severe acute malnutrition, Operational research, Bangladesh

Introduction

Bangladesh has the fourth highest burden of children with severe acute malnutrition (SAM) in the world.[1] There was an estimated 600 000 children with SAM in 2007[2] and the 2011 health and demographic survey showed that 16% of children under 5 years of age were wasted.[3] Such children require prompt medical management, as they are relatively more vulnerable to morbidity and mortality.[4]

The WHO recommends the use of two independent anthropometric criteria to diagnose SAM among children aged 6–59 months. These two criteria are mid-upper arm circumference (MUAC) <115 mm and weight-for-height Z-score (WHZ) <3.[5-6] The MUAC measures circumferential girth (skinfold thickness and muscle mass) of the mid-upper arm by the use of a measuring tape; the WHZ compares a child's weight with the expected mean weight of a child of the same height according to the WHO growth standards. The Z-score is the degree of deviation of the weight of a given child away from the mean value of the reference population, divided by the standard deviation for the reference population.[7] The use of MUAC has recently been endorsed by the WHO for the community-based management of acute malnutrition (CMAM).[5] In practice, MUAC is used on a large scale as a single tool for detecting SAM, because it is cheap, and community health workers (CHWs) learn to use it effectively with minimal training. The tool is also well accepted by children, as its use entails simple circumferential mid-upper arm measurement. For these reasons MUAC is a particularly useful screening tool for nutritional assessments in emergencies and for household screening at community level.[5,8]

MUAC has also proven to be more sensitive than WHZ in identifying high risk SAM children and predicting mortality, particularly in the younger age group (6–23 months).[9–11] However, MUAC and WHZ identify different populations of SAM children with only some degree of overlap.[12] Using only MUAC to diagnose SAM may leave out a proportion of high-risk children who might be severely malnourished as determined by WHZ. Is it justifiable to leave such potentially vulnerable SAM children out of a nutritional rehabilitation programme? In particular, how would such children fare in terms of nutritional evolution, morbidity and mortality?

Médecins Sans Frontières (MSF) is participating in the implementation of CMAM in Kamrangirchar slum in Dhaka, Bangladesh. Routine analysis of nutrition programme data showed that the largest proportion of SAM children were admitted because of a WHZ of <–3 while their MUAC was >115 mm. We conducted a prospective study on this group of children (WHZ <-3 and MUAC >115 mm) in order to: 1. Assess their nutritional outcomes; 2. Report on their morbidity and mortality.

Methods

Design

This was a prospective cohort study.

Setting and study population

The site of the study was Kamrangirchar, an urban slum in Dhaka, Bangladesh. Kamrangirchar has a population of 400 000 living in an area of 3.1 km^2. The slum is not officially recognised as part of the Dhaka metropolitan city and there are no governmental health structures. Provision of health care services is mainly outsourced to non-governmental organisations.

MSF started providing healthcare services for children in Kamrangirchar from May 2010. All services are provided free of charge through two primary healthcare centres (PHC). The project targets malnutrition among children <5 years of age through the CMAM approach. The management protocols are in line with recommended WHO guidelines.[5] The present study was conducted between June 2011 and February 2012. The study population included children aged 6–59 months (height/length between 65 and 110 cm) with a WHZ of <–3 and a MUAC >115 mm. In view of the context of prevalent stunting, children aged over 59 months but with a height <110cm were also included.

Enrolment and follow up

Children included in the study were recruited by assessing both MUAC and WHZ. Those with WHZ <–3 and MUAC >115 mm were recruited for a 3-month follow-up period. Screening took place both at PHC and in the community. Routine single MUAC measurement and WHZ screening is part of standard practice for all children attending the MSF PHC. Children recruited in the PHC were assessed clinically and received treatment for any medical conditions.

Active door-to-door screening in the community was done by a team of CHWs. MUAC was measured using a colour-coded measurement tape graduated in millimeters. Four colour codes are included on the tape: red (50–115mm) indicates SAM, yellow (115–125mm) indicates moderate acute malnutrition, yellow (125–135mm) indicates risk of acute malnutrition, and green (>135mm) implies 'well nourished'. MUAC was measured by wrapping the tape around the mid-left upper arm (midway between the tip of the shoulder and the tip of the elbow). Height/length was measured using a wooden stadiometer with a precision of 0.1 cm. Weight was measured using a hanging scale accurate to 100 g.

During the door-to-door screening, children found with symptoms of fever, cough or diarrhoea were referred to the PHC for further clinical assessment. Children found with MUAC < 115 mm or oedema, or both, were excluded from the study and admitted to the ambulatory therapeutic feeding centres (ATFC) as standard practice. Children with severe medical complications at baseline (measles, lower respiratory tract infection, severe anemia, tuberculosis (TB) and severe diarrhoea) were excluded from recruitment.

On recruitment, all carers were briefed on the study procedure. Verbal and written consent were sought and obtained for 2-weekly home visits for a period of 3 months. A unique identity card was given to the carer to facilitate the follow-up of the child's medical conditions at the PHC if required.

Follow-up home visits were done every 2 weeks by a team of trained CHWs. Carers were informed about the schedule of the prospective follow-up visits and visits were rescheduled (within 7 days) in case of the child's unexpected absence during a scheduled visit. During the follow-up visit, weight and MUAC were assessed and history of any symptoms of fever, diarrhoea (three or more loose motions per day) or cough in the past 2 weeks was taken. Children were referred for admission to the ATFC if their MUAC dropped to <115 mm and/or they had lost ≥10% of their baseline weight. Children were also referred to the PHC for clinical assessment and treatment if they were found with any illness.

Follow-up outcomes were standardized (Box 1). No child recruited into the study was given any ready-to-use therapeutic food unless they required admission to the nutrition programme.

Box 1. Outcomes of a prospective 3-month follow-up of children with a weight-for-height Z score (WHZ) of <−3 and mid-upper arm circumference (MUAC) of >115 in Kamrangirchar slum, Bangladesh

Completed follow-up
A child who completed 3 months of follow-up and:
- maintained a WHZ <–3 (status quo); or
- improved nutritional status: maintained a MUAC >115 mm and attained WHZ ≥–3.

Admitted to ambulatory therapeutic feeding centre (ATFC)
Admitted for a drop in MUAC to <115mm, weight loss of ≥10% from baseline weight or the advent of a severe medical condition.

Lost to follow up
Did not show up for three successive scheduled visits.

Left Kamrangichar
A child who left the study site and about whom the community health worker team was formally informed.

Died
Died from any cause during follow-up.

Prior to study implementation, all PHC staff participating in the nutrition programme were briefed on the study procedures and all data collectors (anthropometric measurers and CHWs) received formal training on the techniques of performing anthropometric measurements. On-the-job supervision and refresher training were conducted at regular intervals to limit errors in measurements.

Data and statistical analysis

The sample size was calculated based on a hypothesis that if children with WHZ <−3 and MUAC >115 mm did not receive nutritional rehabilitation, 30% would lose ≥10% of baseline body weight or would need admission to the nutrition programme as a result of the high morbidity and mortality risk during the prospective follow-up period. To detect the above with 95% confidence and 5% error, the required sample size was calculated to be a minimum of 126 children. To correct for losses-to-follow-up in the context of a generally mobile population, the sample size was increased to 158 children.

Follow-up data of anthropometric measurements and morbidity were gathered using a structured proforma and entered into a Microsoft Excel spread sheet (Microsoft, Redwood, WA, USA). Differences between groups were compared using the χ^2 test. The level of significance was set at $p \leq 0.05$ and 95% confidence intervals (CI) were used throughout. For data analysis we used Epi Info 6.04d software (CDC, Atlanta, GA, USA). Data entry was validated by comparing entered data with randomly selected proformas.

Results

Characteristics of the study population

A total of 158 children were recruited into the study, with a median age of 41 months; 58% were male. Ninety-six (61%) children were recruited through the PHC facilities and 62/158 (39%) through door-to-door screening. At recruitment, the mean MUAC was 126 mm (SD = 19.6, range 116–144 mm), the median weight was 9.6 kg (range 5.7–13.7 mm) and the median height/length was 89.6 cm (range 67–109.5 cm). Because of the frequency of stunting among children living in Kamrangirchar, 28 children with a height of >65 cm and <110 cm and aged more than 59 months were included.

Follow-up and nutritional outcomes

In the course of the study a total of 1002 follow-up home visits were done (average = 167 per 2 weeks), including 222 visits during which children were unexpectedly absent. Of the 158 children recruited into the study, 21 did not complete the 3-month follow-up period: 15/158 (9%) left Kamrangirchar and 6/158 (4%) were lost to follow-up. Of the remaining 137 children for whom we had data on nutritional evolution and outcomes, 9/158 (7%) were admitted to the ATFC: five had their MUAC drop to <115 mm, one had weight loss ≥10% of the baseline weight, two had pulmonary TB and one had severe watery diarrhea. In the five children whose MUAC dropped below 115 mm after recruitment to the study, the baseline MUAC was 116 mm in three of them and 118 mm in two. The drop in MUAC occurred

after 2 weeks in two of the children, after 4 weeks in a further two and after 6 weeks in one child.

Of the remaining 128/158 children who completed 3 months of follow-up, 91/128 (66%) improved in nutritional status, 81/128 (59%) progressed to a WHZ ≥−3 and <−2 and 10/128 (7%) to WHZ ≥−2. There were 37/128 (27%) children who maintained a WHZ of <−3 (Figure 1). Table 1 shows the baseline characteristics of children and the relation to their 3-month follow-up outcomes. The nine children admitted to the ATFC were younger (mean age 20.6 ±16.3 months) and had a lower MUAC (mean 121±4.8 mm).

Morbidity and mortality during follow up

Table 2 shows the morbidity pattern in relation to fever, cough and diarrhoea during the 3 months of prospective follow-up. There were significantly fewer symptoms of cough among those who improved in nutritional status compared with those who maintained a status quo with WHZ <−3 (p = 0.003). There was no other significant difference in morbidity in the groups when compared, with WHZ <−3 as baseline. There was one death, from pulmonary TB.

Discussion

This study, conducted in an urban slum setting in Bangladesh, shows that most (93%) children who were severely malnourished in terms of their Z score (WHZ <−3) but judged as less severely malnourished on the basis of their MUAC (>115 mm) improved in their nutritional status or maintained a status quo
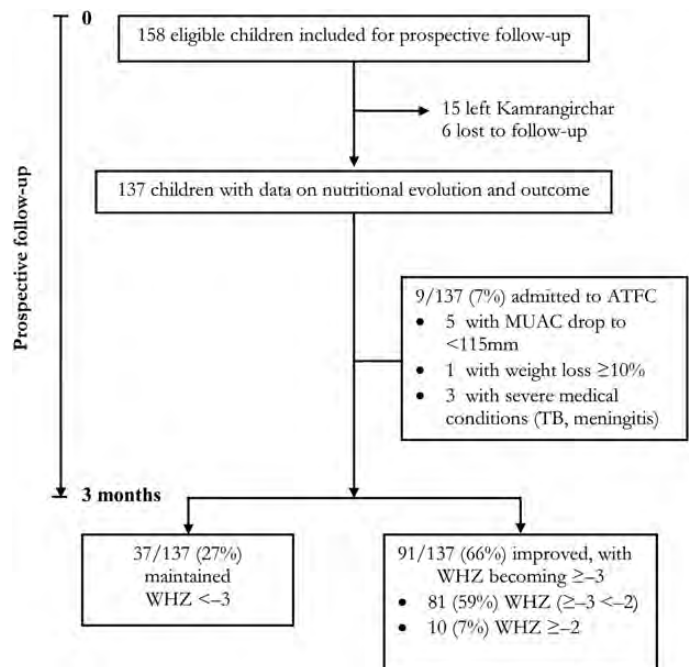
Figure 1. Outcomes of a 3-month prospective follow-up of children with weight for height Z-score (WHZ) <−3 and mid-upper arm circumference (MUAC) >115 mm, Kamrangirchar, Dhaka, Bangladesh. ATFC: ambulatory therapeutic feeding centre.

after 3 months of follow-up. In this context, it would therefore seem possible to rely solely on MUAC for screening and admission into nutritional rehabilitation programmes.

A strength of this study is that it is one of the first prospective studies to assess by WHZ nutritional evolution and outcomes among severely malnourished children in the Asian context. Rigorous attention was paid to follow-up visits at home and to staff training on anthropometric measurements, and the CHW team was well experienced. In addition, because the study was conducted within the unique environment of an urban slum, the findings are likely to reflect the reality on the ground.

The study has a number of limitations. First, we followed children for a relatively short period of 3 months. The rationale for choosing such a duration was supported by the observation of the Malawian PRONUT study, where most of deaths among non-HIV children with SAM occurred in the first 3 months of follow up.[13] Second, although we have no data to substantiate this, it is plausible that the 2-weekly home visits might have had a positive influence on malnutrition-related behaviour of carers or on the use of healthcare facilities, which might also have affected the results.

Third, the findings of this study are representative of a cohort of SAM children without complications, as children with severe medical complications at the baseline were excluded from recruitment. Fourth, regarding the recorded 2-weekly morbidity of children during follow-up, it was not possible to distinguish between new episodes of fever, cough and diarrhoea and persistent symptoms from the previous episode.

Finally, we do not know the outcomes of 21 children because they were lost to follow-up or had changed their geographic residence. The latter is, however, a reality of any study of a migrant population.

It is surprising that, in all, around seven in 10 children with WHZ < –3 gained weight, and moved into the moderate malnutrition category or achieved a normal nutritional status according to their WHZ, in the rather short 3-month follow-up period.

A smaller proportion (27%) maintained their status quo. Both findings are encouraging. It is also reassuring that, despite most children having had one or more common morbidities during follow-up, only nine required admission for nutritional rehabilitation Three of these nine were admitted as a result of severe medical conditions that would themselves have merited the child's admission, irrespective of nutritional status. The one death among the study population was of one of these three children, from pulmonary TB. From a purely nutritional viewpoint, this implies that only six (4%) children were negatively affected by their initial nutritional status, which supports use of MUAC alone to screen children for admission to nutritional programmes.

The inclination to rely on MUAC as a sole measuring tool is supported by studies from Senegal[9] and Kenya;[4] these which have provided further evidence that using both WHZ and MUAC does not improve the detection of high-risk undernourished children, and suggest reliance on MUAC alone. A recent study in rural Bangladesh also demonstrated the feasibility and effectiveness of the CMAM approach, where CHWs used MUAC for community screening and assessment for admission and discharge.[15]

Although 27% of children in the present study maintained their status quo in terms of their nutritional evolution, it is reasonable to think that this group might be at a relatively higher risk of adverse events. Appropriate and well timed access to healthcare for such children would limit the potential deterioration of their nutritional status. Therefore it might be justified to conduct specific research to assess what increased MUAC cut-off threshold (above 115 mm) would be ideal to maximise inclusion of this subgroup. Experience in an African context in Burkina Faso suggests the use of a MUAC cutoff of 118 mm or oedema, or both, as admission citeria for SAM children, which proved to be a useful alternative to WHZ.[16] Increasing the MUAC cut-off for SAM has also been suggested by another study in an urban setting in Nigeria.[17]

Table 1. Baseline characteristics of 137 children in relation to outcomes after 3 months of prospective follow-up in relation to nutritional outcomes in Kamrangirchar, Dhaka, Bangladesh

Baseline characteristics	Improved, with WHZ becoming ≥ –3 (n = 91)	WHZ maintained < –3 (n = 37)	Admitted to ATFC (n = 9)
Age (months)	39.2 ± 19.1	53.5 ± 16.9	20.6 ± 16.3
Sex			
Female	38 (42)	15 (41)	2 (22)
Male	53 (58)	22 (59)	7 (78)
MUAC (mm)	126 ± 6.8	128 ± 7.2	121 ± 4.8
Weight (kg)	9.2 ± 2.2	10.9 ± 2.2	6.9 ± 1.5
Height (cm)	87.4 ± 12.8	96.9 ± 11.6	73.7 ± 8.6

Data are mean ±SD or no. (%). ATFC: ambulatory therapeutic feeding centre; MUAC: mid-upper arm circumference; WHZ: weight-for-height Z-score.

Table 2. Morbidity pattern of 137 children during a 3-month prospective follow-up in relation to nutritional outcomes in Kamrangirchar, Dhaka, Bangladesh

Nutritional outcome	Morbidity: total episodes (mean per child)		
	Fever	Cough	Diarrhoea
Improved, with WHZ becoming ≥ –3 (n = 91)	182 (2)	45 (0.5)	25 (0.3)
WHZ maintained at < –3 (n = 37)	58 (1.6)	63 (1.7)	7 (0.2)
Admitted to ATFC (n = 9)	12 (1.3)	10 (1.1)	4 (0.4)

WHZ: weight-for-height Z-score; ATFC: ambulatory therapeutic feeding centre.
WHZ < –3 and WHZ ≥ –3: fever, p = 0.06; cough, p = 0.003; diarrhoea; p = 0.50.
WHZ < –3 and admitted to the ATFC: fever, p = 0.44; cough, p = 0.16; diarrhoea, p = 0.43.

When the prevalence of malnutrition has been determined by MUAC and WHZ in the same age-group of children, it has been found to be lower according to MUAC in some parts of Ethiopia, Kenya, Chad, Sudan and the Indian subcontinent.[18] These findings may be dependent on body shape. In Ethiopia, one study showed differences in the prevalence of SAM among pastoralists and agrarian groups using both MUAC and WHZ. While body shape had significantly influenced the weight for height measurements in the children, the effect on MUAC was minimal.[19] It is possible that body shape influences the apparent prevalence of SAM in Bangladesh but there are no data to substantiate this.

In conclusion, in an urban slum setting in Bangladesh, where children have proper access to healthcare, it seems acceptable to omit WHZ and rely on MUAC for case finding and admission of children with SAM to nutritional programmes.

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