Is mid-upper-arm circumference a useful tool for screening in emergency settings?

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Summary

In refugee emergencies, rapid collection of nutritional data provides important information for public-health planning. In Rwandan refugee camps in eastern Zaire in August, 1994, a two-step procedure of screening for referral to supplementary feeding programmes was used—mid-upper-arm circumference (MUAC) followed by weight-for-height for children with MUAC of less than 12 cm. To assess the usefulness of this procedure, we analysed data from complete screening of 3681 children in three camps. The performance of MUAC varied with the cut-off chosen; a high cut-off of 14 cm allowed detection of 88% of children with low weight-for-height but at the cost of measuring more than 40% of children in the second step. MUAC preferentially selects younger children as malnourished, and misses older children with low weight-for-height. The groups of children chosen by low MUAC and by low weight-for-height have poor overlap, varying from 20% to 39% overlap depending on age. Thus two-step screening does not save as much time as might be expected and low MUAC cannot be used as a substitute for low weight-for-height. For decision-making in refugee settings, weight-for-height surveys or screening are probably more efficient strategies for data collection.

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Introduction

In emergencies involving refugees or displaced populations, nutritional status is one of the most important public-health indicators, reflecting the risk of short-term mortality.[1] Because children younger than 5 years are most severely affected, the prevalence of undernutrition in this age group is usually assessed as an indicator of the status of the general population. In addition, early in emergencies, individual screening is often used to select malnourished children for treatment or food supplementation.

The most widely accepted measure of nutritional status during emergencies is weight-for-height, because it is most responsive to recent and severe undernutrition.[2] A close correlation has been shown between rates of low weight-for-height and short-term mortality in refugee and displaced populations.[1] However, in emergency settings, it can be difficult to measure weight and height because special equipment is needed. A common alternative is mid-upper-arm circumference (MUAC), for which only a short measuring tape is needed. Weight-for-height requires a reference table for field use, but a fixed cut-off is used for MUAC for all children younger than 5 years, based on the observation in a well-nourished European population that measurements varied by less than 1 cm between 1 and 5 years of age.[3] However, a fixed cut-off of MUAC preferentially identified younger children as malnourished;[4,5] this bias may partly account for MUAC's good predictive value for mortality.[6,7] Younger children have higher rates of mortality; in one analysis, a fixed cut-off of age was slightly more successful than a fixed cut-off of MUAC as a predictor of mortality.[7]

In several manuals for nutritional assessment in refugee settings, MUAC is recommended as the first screen in a two-step procedure, followed by height and weight measurements only for those selected by MUAC, to target feeding programmes to the more malnourished children.[8,9] The aim of the two-step procedure is to reduce the workload by selecting only higher-risk children for the more elaborate assessment. There is no established MUAC cut-off for two-step screening, and recommendations vary from 12 to 14 cm.

In August, 1994, early in the Rwandan refugee crisis in eastern Zaire, we served as nutrition coordinators for the United Nations High Commissioner for Refugees (CB) and the World Food Programme (LN) based in Bukavu, Zaire. In the course of our work, we were shown data from a two-step screening of children that had been carried out in several camps. All children below a predetermined cut-off for MUAC (12 cm) were measured and weighed, while those above the cut-off were deemed to be adequately nourished and were not further evaluated.

To assess the usefulness of MUAC as a screening tool, we collected and analysed data from three refugee camps established in August. We sought to answer the following questions. In the Rwandan refugee population, how well does two-step screening (MUAC followed by weight and height for those below the cut-off) function to identify children in need of supplementary feeding based on low weight-for-height? Second, how do the children identified by low MUAC differ from those with low weight-for-height? Third, what is the most efficient strategy to obtain accurate data on nutritional status for planning under difficult field conditions?

Methods

Measurements were made during initial arrival of refugees into Kashusha, Inera, and Hungo camps, near Bukavu, Zaire, between Aug 11 and 26, 1994. After registration of families, those with children proceeded to an improvised clinic area for measles immunisation, and children who passed under a 110 cm height bridge were measured. Because a child's age was not usually accurately known, 110 cm of height was used as a proxy for 5 years of age. A team of Rwandan and Zairean field-workers measured supine length, weight, and MUAC according to

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MUAC cut-off (cm)	% of children below cut-off	Compared with WFH z-score below −2			
		Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Proportion of low-WFH children missed (%)
12·0	5	26	98	63	74
12·5	9	39	95	54	61
13·0	16	61	90	46	40
13·5	26	74	81	35	26
14·0	41	88	66	27	12

WFH=weight-for-height.

Table: **Comparison of different MUAC cut-off values among 3681 Rwandan refugee children**

standard protocols.[10] To correct for the difference between supine length and height, 0·5 cm was subtracted for children measuring 85 cm or longer. For this assessment, all children under 110 cm in height were measured.

We assessed each child's nutritional status on the weight-for-height curves of the National Center for Health Statistics/Centers for Disease Control and Prevention growth reference. The weight-for-height value is expressed as standard deviation (SD) or z scores. For example, a weight-for-height z-score of −1 corresponds to a value 1 SD below the median of the reference, whereas a z-score of zero corresponds to the median. We defined low weight-for-height as a weight-for-height z-score less than −2 (2·3 percentile).[2] Low weight-for-height is often called acute malnutrition because it usually results from recent, severe food deprivation and/or disease. In settled populations in this part of Africa, the prevalence of low weight-for-height is generally 4–6%.[11]

We examined MUAC with a range of cut-offs. Three standard measures of the performance of a screening test were calculated, with weight-for-height z-score below −2 as the definition of a case: sensitivity (the ability to identify true cases), specificity (the ability to identify true negatives), and positive predictive value (the likelihood that a positive test represents a true case). Finally, we compared the prevalence of low weight-for-height and of MUAC below 12·5 cm, a cut-off commonly used in population assessments, according to the height of the child.

Height was used to substitute for age, with the following categories: 60·0–73·9 cm=6–11 months; 74·0–84·9 cm=12–23 months; 85·0–93·9 cm=24–35 months; 94·0–101·9 cm=36–47 months; 102·0–110·0 cm=48–59 months. Because there is undoubtedly a substantial rate of low height-for-age in the study population, the chronological ages are probably older than those estimated from the height, but we are confident that the 110 cm cut-off includes nearly all children younger than 5 years.

Results

Among 3681 refugee children measured, 12% had low weight-for-height. However, with a MUAC cut-off of 12 cm (that used in several refugee camps in Zaire) only 5% of all children would be selected for weight and height measurements in the second step of screening, and 74% of children with low weight-for-height would be judged adequately nourished (table).

As progressively higher cut-offs are used, a greater proportion of the children with low weight-for-height are identified, but a larger proportion of all children would need to be measured in the second step of screening. A cut-off of 14 cm identified 88% of children with low weight-for-height, but 41% of all children would be selected for weight and height measurements. In addition, as higher cut-offs are used, the likelihood that a child with low MUAC actually has low weight-for-height declines (decreasing positive predictive value). For example, nearly two-thirds of children with MUAC below 12 cm also have low weight-for-height, but only about 1 child in 4 with a MUAC less than 14 cm has low weight-for-height.

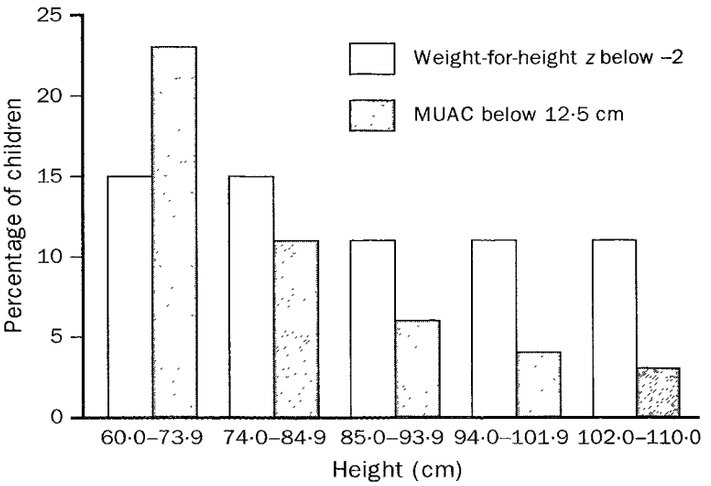

Figure: **Proportion of Rwandan refugee children with MUAC below 12·5 cm and weight-for-height z-scores less than −2 by height**

Height categories were used instead of age categories (see methods).

Low weight-for-height and the commonly used MUAC cut-off of 12·5 cm identify a similar proportion of children as malnourished. However, MUAC is more likely to identify younger children as malnourished (figure). More children in the youngest group are identified as malnourished by MUAC than by low weight-for-height (23 *vs* 15%), whereas among the oldest children fewer were selected by MUAC than by low weight-for-height (3 *vs* 11%).

MUAC and weight-for-height identify somewhat different groups of children. Among the youngest group, of 158 children identified as malnourished by either measure, 39% overlapped (both low weight-for-height and low MUAC), 16% had low weight-for-height but not low MUAC, and 45% had low MUAC but not low weight-for-height. Among the oldest children, the findings were quite different: of 78 children, only 20% had both low MUAC and low weight-for-height, 3% had low MUAC only, and 77% had low weight-for-height but not low MUAC.

Discussion

In the early phases of a refugee emergency, public-health professionals need to collect useful, reliable information for decision-making as efficiently as possible. Two-step screening—MUAC measurement followed by the more established method of weight-for-height—has been recommended as a time-saving measure, to identify malnourished children who traditionally would be referred to a targeted feeding programme. It is evident from this analysis, however, that two-step screening will not save much time. Furthermore, MUAC with a fixed cut-off does not function as a valid substitute for weight-for-height.

These data from Rwandan refugee children show how MUAC screening varies depending on the cut-off. For the purpose of identifying children with low weight-for-height, a generous cut-off (eg, 14 cm) would be essential to avoid missing a large proportion of children with evidence of wasting. However, with such a cut-off more than 40% of the children would still have to be weighed and measured in the second step. The savings in time and effort would not be great.

It is worth emphasising that MUAC screening will not provide an accurate picture of the acute malnutrition rate

in the refugee population. The children chosen by low MUAC and by low weight-for-height overlap poorly, and the results of a MUAC survey cannot be taken to approximate those of a weight-for-height survey. If the purpose of screening is to select younger children (as MUAC will do) for preferential management, a fixed cut-off of height or weight would work equally well.[7] A reliable indication of the nutritional status of the population still requires a weight-for-height survey.

The reason for the poor overlap between low MUAC and low weight-for-height is related to the fact that MUAC with a fixed cut-off identifies both younger children and children who are more malnourished, whereas low weight-for-height, a measure in which age is already taken into account, mainly detects those children who have wasting. For this reason, the relation between the two indicators will vary among different populations.[12–14] The correlation between them is likely to be better when severe malnutrition is common and therefore young age accounts for a smaller proportion of low MUAC than in populations where malnutrition is rare.

What can be recommended as the best strategy for a rapid nutrition assessment in settings such as these refugee camps? If two-step screening is undertaken solely to identify children for targeted feeding, a sufficiently high MUAC cut-off must be chosen to avoid missing children with low weight-for-height. However, this analysis suggests that it would be more efficient to start with weight-for-height screening to collect reliable data quickly for decision-making.

In the three camps in Zaire, based on these data, we directed our efforts to maintaining an adequate general ration and providing a supplementary ration to all children below 110 cm in height. We were confident that our weight-for-height screening gave us an accurate picture of the nutritional status of children as a whole, and that there were few extremely malnourished children requiring treatment. At the same time, the prevalence of low weight-for-height indicated a population at risk of deteriorating nutritional status, such that a preventive measure to protect all children would have a greater impact than a more labour-intensive scheme to supplement only those already malnourished.

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