MUAC versus weight-for-height debate in the Philippines

By Bernardette Cichon

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In the 39th issue of Field Exchange, an article was published by Jennifer Carter and Joel Conkle that discussed the differences in prevalence of acute malnutrition in Cambodia determined using either weight-for-height or mid upper arm circumference (MUAC) measurements. In this article, we share similar observations from the Philippines that challenge the implementation of a community-based surveillance system for early detection and referral of acutely malnourished children to therapeutic feeding programmes. The article discusses possible causes of the differences between MUAC and weight-for-height and calls for more research into this topic.

MUAC measurement of a child in the Municipality of Arakan

MUAC measurements have been used worldwide for identification, referral and admission of severely malnourished children aged 6-59 months to nutrition programmes. It is a good indicator of both muscle mass and mortality risk. MUAC measurements enable community volunteers with minimal training to carry out emergency needs assessments and active case finding. It is a quick, easy and cheap alternative to weight-for-height measurements and has recently been endorsed by the World Health Organisation (WHO).

However, in some populations, large differences have been observed between prevalence of acute malnutrition measured by weight-for-height versus MUAC. In line with this, three surveys carried out by Action Contre la Faim (ACF) in the Philippines found a big discrepancy between the two. This raises a number of questions, such as what causes such a big difference between MUAC and weight-for-height based prevalences in some populations and not in others, what are the programmatic implications, and which is the better indicator for measuring acute malnutrition in the Philippines?
Relationship between MUAC and weight-for-height in Filipino populations

In 1984, Johnson et al first reported in a Philippines study that arm circumference measurements resulted in a lower prevalence of malnutrition as compared to weight-for-height and weight-for-age. They concluded that arm circumference measurements were not adequate for detecting undernutrition in Filipino children. Even though standards and cut-offs used then differ from those used today, five surveys carried out in the southern Philippine island of Mindanao between January 2009 and December 2010 have found similar results. Prevalence of severe acute malnutrition (SAM) was much lower according to MUAC than weight-for-height in all five surveys (see Figure 1) and global acute malnutrition (GAM) in four out of five surveys (see Figure 2).
The MUAC cut-off used for SAM in the UNICEF/WFP survey was 110mm not 115mm.

Not only did the percentage of acute malnutrition differ between the two indicators, but the children selected were not always the same. While a large proportion of children identified as acutely malnourished according to MUAC were also classified as malnourished according to weight-for-height, only a small proportion of children classified as malnourished according to weight-for-height were also classified as malnourished according to MUAC (see Table 1).

**Programmatic implications and dilemmas**

The three surveys carried out by ACF between October and December 2010 were baseline surveys for a new four year integrated food security, nutrition, water and sanitation programme funded by the Spanish Cooperation (AECID). One of the activities of this programme was to enable local health services to provide SAM treatment for those who need it. Active case finding was planned as a priority activity to be carried out by community nutrition workers in the villages using MUAC. However, the large difference between MUAC and weight-for-height means that this approach has to be reviewed. If MUAC is used for active case finding, only a small proportion of children classified as malnourished according to weight-for-height would be identified and referred to the programme (see Table 1).

Table 1: The relationship between weight-for-height and MUAC in three municipalities in Central Mindanao (October-December, 2010)

<table>
<thead>
<tr>
<th></th>
<th>President Roxas</th>
<th>Arakan</th>
<th>Kapatagan</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of children with a W/H of less than -2 z-scores that have a MUAC of less than 125mm</td>
<td>7.8%</td>
<td>15%</td>
<td>14%</td>
</tr>
<tr>
<td>% of children with a W/H of less than -3 z-scores that have a MUAC of less than 115mm</td>
<td>17.6%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>% of children with a MUAC of less than 125mm that also have W/H z-score of less than -2</td>
<td>77.6%</td>
<td>60%</td>
<td>89%</td>
</tr>
<tr>
<td>% of children with a MUAC of less than 115mm that also have W/H z-score of less than -3</td>
<td>100%</td>
<td>0%</td>
<td>-</td>
</tr>
</tbody>
</table>

In addition, the caseload would be so low that it is difficult to justify an intervention. In the municipality of President Roxas, for example, survey results showed 10% GAM and 2% SAM according to weight-for-height, a prevalence high enough (in alert levels) to justify the need for community based management of acute malnutrition (CMAM). Prevalence according to MUAC, however, was much lower (see Figures 1 and 2: 1.3% GAM and 0.2% SAM prevalence, respectively). If MUAC turned out to be a better indicator of malnutrition in this population, the type of intervention needed would differ. The decision to intervene was based on prevalence.
according to weight-for-height, but is this correct? It seems that before we can answer this question, more research is needed to understand the weight-for-height/ MUAC relationship and to determine which indicator is more appropriate in the Philippine context.

**Why is there such a big discrepancy between MUAC and weight-for-height?**

A study carried out by Myatt et al in 2007 that included data from 560 surveys from 31 countries showed that while a similar prevalence of acute malnutrition (GAM and SAM) according to MUAC and weight-for-height was found for the whole data set, there were differences in the MUAC/weight-for-height relationship between and even within countries. While in some populations the prevalence of acute malnutrition was the same according to both indicators, in others MUAC led to a higher prevalence than weight-for height or vice versa. Similar to the results from the Philippine surveys above, prevalence of acute malnutrition according to MUAC was found to be lower in parts of Ethiopia and Kenya, Sudan, Chad, the Indian subcontinent and the Hispanic populations. Equivalent problems have also been observed in Cambodia in the national survey carried out in 2008. Not only did the prevalence differ according to the two indicators, but the children selected were not always the same.

A number of different factors have been associated with the MUAC/weight-for-height relationship such as body shape, age and mortality (see below). Although it is possible that inaccuracies in the measurements are in part responsible for the large differences found, the fact that five surveys carried out by different organisations found the same problem means that this issue deserves further attention.

The multi-centre growth reference study (WHO 2006) confirmed that ethnicity and environment influence growth of infants and children, but according to the WHO these differences were not “large enough to invalidate the general use of the WHO growth standards population as a standard in all populations”. Contrary to this, studies have shown that body shape does seem to influence weight-for-height in some populations. For example, prevalence of acute malnutrition in pastoralist populations as measured by weight-for-height was found to be much higher than according to MUAC: 20% versus 7%. In agrarian populations in the same country, both indicators led to similar estimates. Studies have shown that in these populations, body shape was associated with the MUAC/weight-for-height relationship. Children from pastoralist populations have longer legs and shorter trunks and thus lower sitting to standing height ratio (SSR) than agrarian populations. Whereas weight-for-height was strongly influenced by body shape, the effect on MUAC was very small. It is possible that body shape also plays a role in the Philippines and other Asian populations but no data were found to support this supposition.

It has been shown that children identified as acutely malnourished using MUAC are, on average, younger than those selected by weight-for-height. As a result, it has been shown that the MUAC/weight-for-height relationship is better in children under 24 months and height-adjusted MUAC cut-offs have been suggested. While malnourished children were found in all age and height groups according to weight-for-height in the Philippine surveys, no children with a MUAC of less than 125mm were found in the taller children (see Table 2) and in two of the three surveys no children over 24 months had a MUAC of less than 125mm (see Table 3).

**Table 2: Prevalence of acute malnutrition according to weight-for-height and MUAC by height group in three municipalities in Central Mindanao (October-December 2010)**

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Height groups (cm)</th>
<th>W/H &lt; -2 z-scores</th>
<th>MUAC &lt; 125mm</th>
<th>W/H &lt; -3 z-scores</th>
<th>MUAC &lt; 115mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>President Roxas</td>
<td>=65 and =75</td>
<td>16.1</td>
<td>6.4</td>
<td>4.5</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>=75 and =90</td>
<td>9</td>
<td>0.2</td>
<td>1.7</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>= 90</td>
<td>8.3</td>
<td>0</td>
<td>1.1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>=65 and =75</td>
<td>9.4</td>
<td>6.2</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>Arakan</td>
<td>=75 and =90</td>
<td>5</td>
<td>0.6</td>
<td>0.6</td>
<td>0</td>
</tr>
</tbody>
</table>
MUAC has been shown to be a better predictor of mortality than weight-for-height\textsuperscript{13}. In the Philippine surveys, both mortality rates and prevalence of acute malnutrition according to MUAC were relatively low whereas prevalence according to weight-for-height was much higher. It is possible that morbidity plays a role in this relationship.

Malnutrition can be caused by lack of food and/or infection. While in both cases children lose weight, it is possible that effect on body composition and thus arm circumference differs. In malnourished children, once glycogen stores are used, fat becomes the main fuel for energy production and protein breakdown is reduced. During infection, protein turnover is increased due to an increased need for proteins involved in the body’s response to infection. It has been shown that while protein breakdown and synthesis are reduced in malnourished children, it increases if the malnourished children have an underlying infection\textsuperscript{14}. Muscle is a good source of protein and MUAC is directly related to arm muscle mass. It is therefore possible the increased protein breakdown in infected malnourished children leads to a lower MUAC than uninfected malnourished children. This might also explain why MUAC is a better predictor of mortality than weight-for-height. Furthermore, it is possible that in locations where infection is generally high, for example due to an unhealthy environment or high prevalence of HIV/AIDS, MUAC leads to higher estimates in malnutrition than in other contexts.

**MUAC, weight-for-height, or both?**

The WHO recommends that where differences between these two indicators exist, both should continue to be used. Some programmes have used a two stage approach where MUAC has been used for referral and weight-for-height for admission to programmes\textsuperscript{15}. This has led to the problem of rejected referrals and therefore some organisations are now using both as admission criteria. While such an approach is possible in populations where prevalence of acute malnutrition is higher according to MUAC, in the Philippines this would not be possible. Using MUAC for identification and referral at the community level would mean that, as mentioned above, a very large proportion of children that are malnourished according to weight-for-height would be missed and the caseload would be so low that it would be difficult to justify the need for a programme. On the other hand, using only weight-for-height for active case finding, referral and admission is costly, takes more time and requires much better trained staff. One possibility might be to increase the MUAC cut-offs to a value that corresponds better to weight-for-height.

### Table 3: Prevalence of acute malnutrition according to weight-for-height and MUAC by age group in three municipalities in Central Mindanao (October-December 2010)

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Height groups (cm)</th>
<th>W/H &lt;-2 z- scores</th>
<th>MUAC &lt;125mm</th>
<th>W/H &lt;-3 z- scores</th>
<th>MUAC &lt; 115mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>President Roxas</td>
<td>= 24 months</td>
<td>12.3</td>
<td>3.2</td>
<td>2.7</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>= 24 months</td>
<td>9.3</td>
<td>0</td>
<td>1.6</td>
<td>0</td>
</tr>
<tr>
<td>Arakan</td>
<td>= 24 months</td>
<td>5.4</td>
<td>5</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>= 24 months</td>
<td>5.7</td>
<td>0</td>
<td>1.3</td>
<td>0</td>
</tr>
<tr>
<td>Kapatagan</td>
<td>= 24 months</td>
<td>11.8</td>
<td>3.3</td>
<td>1.5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>= 24 months</td>
<td>4.6</td>
<td>0.4</td>
<td>0.7</td>
<td>0.2</td>
</tr>
</tbody>
</table>

MUAC has been shown to be a better predictor of mortality than weight-for-height\textsuperscript{13}. In the Philippine surveys, both mortality rates and prevalence of acute malnutrition according to MUAC were relatively low whereas prevalence according to weight-for-height was much higher. It is possible that morbidity plays a role in this relationship.
However, Myatt warns us not to automatically accept weight-for-height as the gold standard because it can overestimate the prevalence of malnutrition in some populations, as shown in pastoralist populations in Ethiopia (see above). So the question that we face in the Philippines is not how best to find children with a low weight-for-height in the community but what is the better descriptor of nutritional status.

We must remember that both MUAC and weight-for-height are anthropometric measurements and are not direct indicators of nutritional status. Weight-for-height compares weight to height and while it is very likely that a child with a weight-for-height of less than -3 z-scores is malnourished in some form or another, a child with a z-score of greater than -2 is not necessarily well nourished. Weight-for-height cannot tell us anything about nutrient stores and body composition, the latter of which does influence weight. Muscle, for example, weighs more than fat. Body Mass Index (BMI), another anthropometric indicator that compares weight to height, has been known to classify healthy athletes with a low percentage of body fat as obese. Contrary to weight-for-height, MUAC is directly related to muscle mass and therefore gives us some idea about body composition. In addition it is a better predictor of mortality than weight-for-height and is independent of body shape. Admitting children based on MUAC might therefore focus limited resources to those most at risk of death. However, it is well known that with the 2006 WHO standards, children are selected earlier which increases case load but improves chances of survival. Another question that therefore needs to be answered is whether in the Philippines (where many more children are classified as severely malnourished according to weight-for-height than MUAC) waiting until children have a MUAC of less than 115mm would reduce their chances of survival.

**Conclusions**

In the immediate term, as long as we do not fully understand the risk of mortality in children with a weight-for-height of less than -3 z-scores but a MUAC greater than 115mm, all children classified as malnourished according to both indicators should receive treatment in the Philippines. The easiest option to find as many malnourished children in the community as possible would be to increase the MUAC cutoff used for referral. This cut-off would need to be carefully chosen to avoid the problem of rejected referrals. Alternatively, weight and height measurements could be used in addition to MUAC, which would ensure that children classified as malnourished according to both indicators would be found. Since it will not be possible for community volunteers to carry heavy height boards, measuring tapes or height sticks have been suggested as alternatives. The problem is, of course, that height measurements would not be as accurate as with the height boards, active case finding would be more time consuming and it is unclear how many of the barangay nutrition scholars (community volunteers) are able to read weight-for-height tables.

Before a more conclusive recommendation can be made in the Philippines, the weight-for-height/ MUAC relationship in this population needs to be better understood. This will require research into the influence of body length measurements of a child in the Municipality of Arakan, Mindanao
shape and morbidity on the weight-for-height/MUAC relationship. The appropriateness of the use of WHO standards in this population should be investigated, as well as the risk of death in children with a weight-for-height of less than -3 $z$-scores but a MUAC of greater than 115mm. If WHO standards turn out to be appropriate and weight-for-height a better indicator than MUAC, MUAC cut-offs need to be revised for this population.

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2UN Standing Committee on Nutrition. Task Force on Assessment, Monitoring and Evaluation. Fact Sheets on Food and Nutrition Security Indicators/Measures: Mid- Upper Arm Circumference (MUAC).


6Myatt and Duffield, 2007. See footnote 5.


11See footnotes 5 and 8.


16 Myatt and Duffield, 2007. See footnote 5.