MUAC and weight-for-height in identifying high risk children

Summary of research

The World Health Organisation (WHO) and UNICEF propose to use two independent criteria for diagnosing non-oedematous severe acute malnutrition (SAM) in children aged 6–60 months: mid-upper arm circumference (MUAC) less than 115 mm and weight-for-height z-score (WHZ) less than -3 (based on WHO growth standard). WHZ has been used for years in clinical settings for diagnosing SAM, but the use of MUAC was introduced more recently with the development of community-based management of SAM. In practice, large-scale programmes increasingly use MUAC as single diagnostic criteria as it is closely related to the risk of dying and is easy to implement at the community level after minimum training by health workers or even by volunteers. MUAC and WHZ, however, do not identify the same set of children as having malnutrition, and using only one of the diagnostic criteria proposed by WHO may potentially leave some high-risk children untreated.

A newly published study used an old data set from Senegal to examine the risk of dying of children having either a low MUAC or a low WHZ or a combination of both in the absence of treatment. The specific objective was to test whether combining both MUAC less than 115 mm and WHZ less than -3 would improve the identification of high-risk children.

The original study, which was conducted in 1983 and 1984, followed an open cohort of about 5000 children, comprising all children under 5 living in 30 villages. The team visited the children four times at six-month intervals in May and November of 1983 and 1984. At each visit, comprehensive anthropometric measurements were taken (weight, height, head circumference, arm circumference, triceps skin fold and subscapular skin fold).

For this analysis, the data from all children aged 6–59 months at the time of anthropometric assessment were used. WHZ was calculated using the WHO growth standards. Receiver operating characteristic (ROC) curves (sensitivity vs. 1-specificity) were calculated for WHZ and for MUAC using death within six months as outcome. Only the part of the curve with a percentage of false positive less than 5% was explored, as these indicators are always used in a context of limited treatment capacity and a high specificity is required. The anthropometric index with the highest ROC was considered as more adapted to identify high-risk children.

Specificity and sensitivity of ‘MUAC less than 115 mm AND WHZ less than -3’ and also for ‘MUAC less than 115 mm OR WHZ less than -3’ were also estimated and positioned in relation to the ROC curve of MUAC and WHZ.

In total, 12,638 measures were made on 5,751 children, and 303 deaths occurred within six months of the nutritional assessment. The criteria ‘WHZ less than -3 AND MUAC less than 115’ had a specificity of 99.0% and a sensitivity of 5.9%. For ‘MUAC less than 115 mm OR WHZ less than -3’, the specificity was 96.9% and the sensitivity was 13.2%. Both points combining WHZ less than -3 and MUAC less than 115 mm were positioned above the WHZ ROC curve but below the MUAC curve.

For a MUAC, the threshold of 112 mm had a specificity of 99.1, comparable with the specificity observed for ‘MUAC less than 115 AND WHZ less than -3’. However, the sensitivity of MUAC 112 mm was 6.0%, slightly higher than for these two indices combined. For a MUAC of 119 mm, the specificity was 96.9%, comparable with the specificity of ‘WHZ less than -3 OR MUAC less than 115 mm’. However, the sensitivity was higher at 14.9%.

This study confirms that MUAC has a better ability than WHZ to assess the risk of dying. This is consistent with
a previous analysis of the same data set, which showed that MUAC was superior to weight-for-height (percentage of the National Centre for Health Statistics median) to identify high-risk children. This is also consistent with other reports from the literature.

In addition to confirming previous findings, this study also shows that using WHZ equal to or <-3 and MUAC equal to or <115 mm together did not improve the identification of high-risk children. The position of two possible combinations of WHZ equal to or <-3 and/or MUAC equal to or <115 mm compared with the MUAC ROC curve suggests that using the two indices together may lead to poorer results than using MUAC alone. Arguably, using WHZ equal to or <-3 AND MUAC equal to or <115 mm increases the specificity, but this can be obtained by using a lower MUAC cut-off (112 mm) with a greater sensitivity. Conversely, using WHZ equal to or <-3 OR MUAC equal to or <115 mm increases sensitivity, but it also decreases the specificity. Using a MUAC cut-off of 119 mm, with the same specificity as WHZ equal to or <-3 OR MUAC equal to or <115 mm, will result in a higher sensitivity.

Several explanations have been given to explain the apparent superiority of MUAC to assess the risk of dying. A first hypothesis is that MUAC, which grows continuously with age, selects younger children with a higher risk of dying when used with a cut-off not adjusted for age. Another explanation might be that MUAC is closely related to muscle mass. A close association between MUAC and muscle mass has been suggested by corresponding measures of body composition by Dual energy X-ray absorptiometry. The underappreciated metabolic role of muscle both in health and disease may explain its association with survival.

Finally, it has been shown that WHZ differences are largely influenced by leg length, unrelated to the nutritional status of the child, which may also decrease its ability to identify high risk children.

This study was based on MUAC data carefully collected by skilled investigators. Its findings may not be extrapolated to other settings where these conditions are not met. Appropriate training of field workers and standardisation of measures are probably needed to use MUAC successfully in field conditions to identify high-risk children. The use of colour banded MUAC straps could also help to minimise measurement errors.

In conclusion, this study shows that there is no benefit for programmes in using both MUAC equal to or <115 mm and/or WHZ equal to or <-3 to identify high-risk children. If a higher sensitivity is required for programmatic reasons, for instance to take into account a poor food security, it seems preferable to increase the MUAC cut-off rather than combine it with WHZ. In the same way, if a higher specificity is required, in case of limited treatment capacity, lowering the MUAC cut-off should be preferable.


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