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Use of MUAC for Severe Acute Malnutrition

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Low mid-upper arm circumference (MUAC < 115 mm), low weight-for-height (WFH < -3 z-scores of WHO standards) and/or oedema are internationally recognised independent diagnostic criteria for severe acute malnutrition (SAM)⁽¹⁾. For community based programmes, however, it is recommended to use only MUAC and oedema.

Why is it recommended to use mid-upper arm circumference (MUAC) to identify children with severe acute malnutrition in need of treatment?

The main advantage of MUAC compared to other nutritional indices is that it is at least as good or even better to identify children with a high risk of death in need of treatment. This is based on a series of longitudinal population studies which took place in the 80's and early 90's, before the advent of modern community management of SAM. These studies followed-up children with different degrees of malnutrition, most of whom did not receive any form of adequate therapeutic feeding. These studies compared the sensitivity of different nutritional indicators to assess the risk of death at high levels of specificity. They demonstrated that MUAC had the highest ROC curve, an indication of better performance as a diagnostic tool.⁽²⁾

Another advantage of MUAC is its ease of use. In contrast to weight-for-height (WFH), which was previously used as main criteria to define SAM, MUAC is simple to use both in the community and in the health facility, and easy for service providers and caretakers of children to understand. This facilitates achievement of a high coverage at the screening and/or diagnostic stage, a key component of programme success. Also, the simplicity of MUAC makes it easy to measure frequently, which is important when identifying high risk children. Optimal assessment is obtained with monthly screening,⁽³⁾ which is impossible to achieve when using WFH. So, unlike WFH, MUAC allows for early SAM case detection, before the onset of complications, which improves the efficacy of treatment.

Why is MUAC the best index to assess the risk of death ?

There are two main factors that contribute to the value of MUAC to assess the risk of death. First, there is clearly an age effect. MUAC grows continuously with age, and when a fixed cut-off is used for identifying SAM children, more young children are selected than with an index independent of age such as WFH. As younger children have a higher mortality, this improves the selection of a high risk group. Another key factor is the relationship between MUAC and muscle mass and to some extent to fat mass.⁽⁴⁾ Survival is linked to fat stores during starvation⁽⁵⁾ and muscle mass during infections⁽⁶⁾. Based on this, there is some physiological rationale that links MUAC and survival. Of note, these two explanations are not exclusive as body proportions and body composition change with age, with young children having comparatively a low muscle mass,⁽⁷⁾ which puts them at greater risk of death when they suffer from malnutrition. This may explain why WFH is not as effective as MUAC, because WFH classifies in the same risk category children of different ages with the same weight deficit, not taking into account that young children have a low muscle mass to start with, putting them in a higher risk category for the same weight deficit.

Should MUAC be adjusted for age or height ?

In the age group 6-59 months, adjusting MUAC for age or height does not improve the assessment of the risk of death⁽³⁾⁽⁸⁾. If an age adjustment is used, it will then eliminate the beneficial bias favouring the selection of younger, higher risk children. So there is no advantage to use these adjustments. Beyond the age range 6-59 months, some adjustment is likely to be necessary, but to date there has been no studies that link possible modes of adjustments with risk of death or to response to treatment, two key factors to consider when proposing cut-offs. Also, a lower cut-off is likely to be needed for children below 6 months, but so far it is not known where to set it.

Should WFH also be checked before admission into programmes in SAM children referred from the community for a low MUAC?

The use of WFH in addition to MUAC is not recommended. The additional measurement is not necessary, is time consuming, and can lead to confusion in treatment protocols. Children with a low MUAC are at high risk of death and should be treated independently of their WFH. Denying treatment to children with a low MUAC because their WFH is above -3 z-score leaves high-risk children untreated. Also, rejecting a child referred from the community for a low MUAC based on WFH is disruptive to families, damaging for programmes and leads to low programme coverage⁽⁹⁾.

Are the same children identified with a low MUAC and a low WFH?

No, these two criteria identify two different groups of children. As a rule, those identified with MUAC < 115 mm tend to be younger than those identified with a WFH < -3. This results from the continuous increase of MUAC with age which leads to the selection of younger children when using a fixed cut-off. Also, WFH is influenced by body shape and proportions. WFH is lower in children with long legs,⁽¹⁰⁾ and higher in those with large chest or abdominal circumferences⁽¹¹⁾. This is a concern as children with long legs are usually healthier⁽¹²⁾ and those with large chest or abdominal circumferences are unlikely to have larger nutritional reserves, and more specifically higher muscle mass. This is likely to weaken the link between WFH and survival. These non-nutritional variations of WFH can lead to discrepancies with MUAC.

If children identified with MUAC and WFH are not the same, should we use these two indices together to identify more at risk children?

Using both indicators will classify more children as SAM. However, this approach is not recommended, as this increased sensitivity to detect high risk children is obtained at the cost of a decrease in the specificity.⁽¹³⁾⁽¹⁴⁾ In situations where a higher sensitivity is desired, for instance when there is a major food insecurity, it would be more appropriate to use a higher MUAC cut-off rather than including WFH in the screening scheme. A higher MUAC cut-off, however, should only be used in situations where a high coverage is already achieved.

What to do with children with a MUAC > 115 mm and a WFH < -3 ?

Available data from old longitudinal population studies of untreated children suggest that survival is mainly related to MUAC and that adding WFH to models has only little effect on the estimation of the risk of death.⁽⁸⁾ Therefore, there is no clear rationale for admitting these children into therapeutic feeding programmes. Of note, these children are usually older and often have a special body shape with long legs. If the programme has the capacity to treat more children, analysis of sensitivity specificity curves suggests that it is more appropriate to increase the MUAC cut-off rather than using a combination of both MUAC and WFH.⁽¹³⁾⁽¹⁴⁾

WFH has been used in clinical settings for years as an index of the nutritional status of children. Should it be considered as a “gold standard” in preference to MUAC when assessing malnutrition?

No, this frequent assumption is based on no evidence. Physiology suggests that survival of a malnourished child is related to its body composition, in particular on its fat stores or muscle mass depending on the presence of infection⁽⁵⁾⁽⁶⁾, and not to its deviation from a growth standard. Muscle mass is very difficult to measure in children and its link with anthropometry is not clear. Early estimation of muscle mass based on urinary creatinine excretion suggests that it has a closer link with MUAC than with WFH⁽⁴⁾. More recent studies based on DEXA¹ also suggest that MUAC is presumably better than WFH to assess the proportion of muscle mass in the body⁽¹⁵⁾⁽¹⁶⁾. MUAC could be more relevant compared to WFH to assess muscle mass in groups of children of different ages, as WFH is designed to be independent of age, whereas muscle mass increases with age⁽⁷⁾.

Should WFH be used as discharge criteria ?

This is not recommended for children admitted on the basis of a low MUAC. First, when the WFH discharge criteria is low (e.g., ≥ -2 z-scores), some children with a low MUAC will meet discharge criteria based on WFH right on admission or soon after, which may lead to confusion. Also, there is no simple way to define a discharge criteria based on WFH. Some children will remain malnourished even when they are above the -2 z-score cut-off. On the other hand, having a higher cut-off will keep children who have a thin morphology -and are possibly well-nourished - unnecessarily in programmes. Of note, in a well nourished population, about 16% of children have a WFH below -1 z-score, a cut off previously recommended by WHO as discharge criteria. Using this cut-off will make these children supplemented for too long and carries a risk of making them fatter than needed. Using fixed cut-offs for MUAC as admission and discharge criteria avoids this problem.

What about using the percentage weight gain as discharge criteria for children admitted on MUAC?

In their 2009 Joint Statement, WHO and UNICEF recommended the use of percentage weight gain (15 to 20%) as discharge criteria. At that time, it was not clear that MUAC responded to treatment and could be used as discharge criteria. This approach of using percentage weight gain, however, should not be continued, as this results in treating the most malnourished children for a shorter period than children selected just below the threshold who will be treated for a very long period; neither extreme being appropriate.

There is now good evidence from programmes that MUAC responds to treatment and it seems more appropriate to use fixed MUAC cut-offs (e.g. >125 mm) as the discharge criteria.

¹ Dual-energy X-ray absorptiometry (also called DXA) is a means of measuring body composition. Two X-ray beams with differing energy levels are aimed at the patient to obtain images of soft (fat and lean) and bones tissues. Lean tissue mass in arms and legs can be regarded as an estimate of muscle mass.

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