REVIEW ARTICLE

It's Past Time to Change Mid-upper Arm Circumference (MUAC) Standards

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ABSTRACT

Obesity has become the most common form of malnutrition in the first world, but under nutrition, particularly among children, continues to pose substantial threats to the developing world. The hope for these developing nations to be able to take their place in the worldwide community rests on the people benefitting from education and infrastructure can enable them to raise the standard of living, improve health, and receive adequate medical care. Current research has demonstrated the sensitivity of the brain and intellectual development to subtle alterations such as micronutrients; the effects of significant malnutrition during the critical years of development are far greater. As the first world considers extending help to third world countries, one of the most important interventions is nutritional support targeting vulnerable children as they prepare to take advantage of educational opportunities. A critical first step in that process is having cheap, easily taught screening methods to identify those vulnerable children. MUAC is such a tool, but the available data suggests that the currently utilized standards miss many of the most vulnerable children. That needs to change.

Introduction

Malnutrition has long been understood to be a risk factor for infections, stunted growth, and death.[1] While much of the world looks at micronutrients and the influence of the GI microbiome on brain development, [2] much of the developing world continues to use demonstrably insensitive screening measures for detecting the children who are most at risk for malnutrition and its consequences. As we demonstrated,[3] a MUAC (mid-upper arm circumference) of 12.5 cm is an inadequate screening tool for children between 2 and 5 years of age. We are not the only or the first investigators to show that using a MUAC of 12.5 cm as a screen misses many malnourished children between two to five years.[4,5,6]

What is the history behind the adoption of 12.5 cm as a cutoff for malnutrition? Though it is uncertain how this became the standard, one of the contributing factors was a WFP (World Food Program) grant aimed at helping pregnant and lactating women and their offspring. The targeted beneficiaries for that program were primarily the women and babies under two years. If there is an agreed upon standard definition of under-nutrition, it is being less than 2 SD below the mean for age and sex.

Using that standard, MUAC of 12.5 cm was only adequate for children less than one year. Though that fit the needs of the above referenced WFP program for Lactating women and infants, it is far from adequate for children above 2 years and should be abandoned; indeed, it should be reserved for children less than 1 year.

It defies what is commonly known about childhood growth and development to seek to use a single MUAC cutoff to screen children between 6 month and 5 years of age, a period of some of the most rapid growth and change in the life of all individuals. Laillou, et al,[2] suggested using 13.3 cm as the one cutoff, but as Das et al,[3] clearly show, the MUAC median and 2SD from the mean go up with age, as would be expected. As shown in the table below, derived from data from de Onis,[3,4] there are slight differences in median and 2 Standard Deviations (2SD) below the median based on the sex of the child, but the most obvious change is with age, as would be expected. Using the chart below, it is clear that using a MUAC cutoff of 12.5 cm as a screening tool would be valid only for boys 1 year or less, and girls 18 months or less.

Age (months)	Boys Median (cm)	Boys (-2SD cm)	Girls (-2SD cm)	Girls Median (cm)
6	14.2	12.2	11.8	13.9
12	14.6	12.5	12.1	14.2
18	14.9	12.8	12.4	14.5
24	15.2	13.0	12.7	15.0
30	15.5	13.3	13.1	15.4
36	15.8	13.5	13.3	15.7
42	16.0	13.6	13.5	16.0
48	16.2	13.8	13.7	16.3
54	16.3	13.9	13.9	16.6
60	16.5	14.0	14.0	16.9

Methods: Literature review, aided by AI.

Discussion: In evaluating that standard, let us remember that a good screening test should capture virtually all those at risk, though some of those included might be found to be a false positive. We use a two step screening for HIV, knowing that some of those found by the Determine method may be negative with Unigold. Using a MUAC of 12.5 cm will result in few false positives, but potentially many false negatives if we use the accepted standard of two SD below the mean for age as a more definitive measure of under nutrition.[3] Other standards, such as weight for height, BMI, height or weight for age, are far more difficult to utilize in the developing world because of costs. MUAC tapes are cheap and easy to use. They are the only practical screening tool for the countries that most need to identify under-nourished children, so it is essential that we use the tool properly. As it stands, MUAC of < 12.5 cm is the standard for the screening programs for children between 6 months and 5 years, so it is of little surprise that the majority of children identified are under 2 years of age.[4] Since children under two have benefitted the most from breast feeding, it is unlikely that those over three would have a lower incidence of malnutrition. The problem is that the screening fails to identify older children who are malnourished. In a study using MUAC values 2 SD below the median to identify those malnourished, the incidence of malnutrition is high between 3-5 years of age, but significant numbers would not have been identified utilizing 12.5 cm as the cutoff. [3,5,6,7,8,9]

Why are the children from 3 to 5 years particularly vulnerable? In much of the developing world, particularly in Africa, breast feeding is the primary and most reliable source of nutrition for infants. Indeed, risk factors for malnutrition in the developing world include delayed institution of breast feeding (> 1 hour), lack of exclusive breast feeding for the first six months, and early termination.[7] Many mothers continued breast feeding through the first two years of life. That is particularly important in food vulnerable areas, such as South Sudan. In the vulnerable child, the withdrawal of breast milk without the ability to supplement with other foods may result in profound nutritional deprivation. Many of the children who are of borderline nutritional status while nursing will fall into the malnourished ranks when weaned. That means they not only lose any immune benefit they still obtain from colostrum but they will also add to that insufficient nutrition, another risk factor for infection. There is clear evidence of increased risk for death in children who are malnourished.[1]

But possibly even more important is the issue of brain health and intellectual development because its effects

touch far more lives. Most of the students join formal education between the third and sixth year of life. There is clear evidence that under-nutrition results in poor intellectual development, particularly in the realm of executive functions—those functions most needed for self control and productivity in society.[9] Moreover, any form of malnutrition, whether under or over nutrition (obesity) has been shown to negatively impact academic performance in primary and secondary school.[10] Studies have shown that malnutrition in early childhood results in long term microscopic deficits, suggesting that failure to identify malnutrition in these vulnerable years results in permanent deficiencies.[11, 12]

Admittedly this call comes at a difficult time for international aid groups such as WFP and UNICEF. Because of war and political instability, record numbers of children and adults are at risk for acute starvation. Mass starvation is forecast in Gaza and Sudan because of ongoing conflicts in those countries. But denial is a poor way to address problems. The gap in intellectual development between the first world and developing countries is increasing; at least part of that deficit can be attributed to children starting school with malnutrition and its adverse effects on learning. These children already face enormous obstacles as they seek to take their place in the world community. Many are born into homes with illiterate parents and limited to no opportunities for reading and development. We are adding to their obstacles when we fail to identify the under-nourished in their ranks. Only as we use the correct tools to identify the extent of the problem can we begin to address this profound need.

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