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# The Critical Need to Adopt an Appropriate Screening Tool for Malnutrition to Assist Third World Country Development

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**ABSTRACT**

As the First World seeks to lay the groundwork to enable developing nations to join the international community as equal partners, one simple and critical step has been ignored for too long. The evidence for the pernicious effects of malnutrition on brain development and intellectual maturity is overwhelming, has been present for decades, and we are discovering more every day. Malnutrition has been shown to alter brain development, lower IQ compared to socially comparable cohorts, interfere with the development of higher executive function, and disrupt appropriate societal behavior. Mid-upper arm circumference (MUAC) of 12.5 cm is the standard promoted by the WHO and other international agencies to screen for malnutrition in children 6-60 months, but we present data from various studies (including our own) to show that the standard has never been rational and misses a large percentage of children in their most critical years of growth and development, particularly those who are approaching school age. If there is a good faith desire on the part of the most economically advanced countries to help the developing nations to pull out of generations of poverty, one of the easiest and most critical steps is to adopt a more appropriate screening program for undernutrition. We recommend the immediate abandonment of 12.5 cm as the screening tool for children between 6 and 60 months and adoption of 14 cm as a more appropriate screening tool.

## INTRODUCTION

In *Brave New World* (Huxley), the reproductive centers purposely deprived many of the developing embryos at critical points in their development so that they would fulfill the need for subservient roles in society. Though we do not suggest that current screening programs for undernutrition in today's society have such a horrific aim, the fact is that current methods potentially have had the same effect. The link between inadequate nutrition in infancy and early childhood with diminished brain development and poor academic performance is well established as an independent risk factor.[1,2,3,4,5,6,7,8, 9, 10] Those effects have been demonstrated to extend into the second decade of life and cause substantial deficits in academic performance.[11] Though the effects of malnutrition are most pronounced in the early years of life, there is no clear cut-off of those pernicious effects in the first five years of life.[12] These effects are clear even when measuring subtle malnutrition in the early years and subsequent academic deficiencies in First World countries.[9]

In sub-Saharan Africa, the issues around malnutrition deal with far grosser measures of well-being—death and susceptibility to infectious diseases. However, the deficits in IQ and the loss of the ability to function in society secondary to malnutrition may result in greater devastation for Third World countries. The two most critical steps of nations supporting the development of a middle-class are achieving higher education and a stable infrastructure to provide economic opportunities.[13] Malnutrition in early childhood substantially inhibits the ability of individuals to achieve higher education.[4,5,6]

## METHODS

Literature review, assisted by AI.

## RESULTS

Multiple studies have shown that using a MUAC of 12.5 cm to screen for malnutrition in children 6-60 months misses large swaths of the population, particularly those greater than 24 months of age.[13, 14, 15, 16, 17] This is hardly surprising since 12.5 cm is more than two standard deviations (-2SD) below the mean for MUAC for children 24 months of age in both boys and girls.[18]

To illustrate the point, we have included data from our published field work.[17] In children from 6 to 60 months, we had a 14.8% false negative rate—children who were greater than -2SD below the mean for their age, but missed when using MUAC of12.5 cm for screening. The false positive rate—children picked up as malnourished using MUAC of 14 cm, but who were actually less than -2SD below the mean for age—was 8.3%. Looking specifically at children preparing to enter formal education (between 3 and 5 years of age), the false negative rate was 19.6% (data not shown). Any screening method, particularly for critical health issues, that misses 15 to 20% of the affected population is a poor screening tool.

**Table 1: Group Data for identification of malnourished patients 6-60 months of age**

| | Group A | Group B | Group C | Group D | Total |
|---|---|---|---|---|---|
| Total | 61 | 56 | 60 | 52 | 229 |
| MUAC < 14 | 19 (31.1%) | 14 (25%) | 18 (30%) | 21 (40.4%) | 72 (31.4%) |
| MUAC < 12.5 | 3 (4.9%) | 5 (8.9%) | 6 (10%) | 5 (9.6%) | 19 (8.3%) |
| False (+) 14 | 5 (8.2%) | 3 (5.4%) | 4 (6.7%) | 7 (13.5%) | 19 (8.3%) |
| False (-) 12.5 | 11 (18%) | 6 (10.7%) | 8 (13.3%) | 9 (17.3%) | 34 (14.8%) |

These data were obtained from 4 different schools in Maridi, South Sudan. There was a dramatic difference in those identified as malnourished when using a MUAC of 14 cm as opposed to using 12.5 cm to identify malnutrition.

**Table 2: MUAC norms and -2 SD for age and sex**

| 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 |

Because we had difficulty finding these normative data, we are including MUAC norms from 6-60 months, both median and -2SD below the median for girls and boys.

## DISCUSSION

Screening programs are designed to identify all individuals at risk for having the disease with the understanding that false positives (normal individuals who do not actually have the disease) will occur, but after the initial screen, those normal patients can be distinguished. We screen for HIV using a two-step method, understanding that the first step may include false positives (those who do not have HIV), but we capture all patients who have HIV. Those who are not truly positive can be distinguished from those who are utilizing a confirmatory test.[22] But even the false positives have some value. Typically, patients identified in the initial screening but found negative using the more definitive test are encouraged to return for more testing in the next three months. We submit that screening for malnutrition should be carried out in the same manner.

MUAC is in many ways the ideal screening method for undernutrition in developing nations. The tapes are inexpensive, the methods are relatively simple and quickly taught. Other methods that work well in First World countries are not readily available in developing nations. Accurate weighing scales and stadiometer measurement of height are widely available in the US, Europe, and

the more advanced countries in Asia. Most pediatric and family practice clinics in First World nations have readily available charts for height, weight, and their ratio compared to age. Those methods of screening may be the most objective, but they are too expensive to be widely utilized in much of the developing world where undernutrition is still prevalent. MUAC tapes can fill that void.

We acknowledge that defining appropriate nutrition is a challenge. Body-mass index (BMI) of greater than 30 has been an accepted measure of obesity. That measure is now being challenged because of the rapid increase in BMI in the general population of the US and other countries,[23] and more specific measures of obesity are needed. There are problems with BMI. Muscular individuals tend to have a higher BMI than peers with comparable percentage of fatty tissue, and BMI responds slowly in people who increase their muscles and decrease their fat percentage. Experts have called for more discriminating methods for determining obesity, but BMI remains a good screening program. The most readily agreed upon measure of significant undernutrition is when an individual is two standard deviations (SD) below the mean for their age, whether that is weight, height, or MUAC. The standard used for screening for malnutrition in virtually all third-world countries for children between 6-60 months has been 12.5 cm.

The critical role of adequate nutrition in infancy and early childhood for normal brain development and academic performance has been known for decades.[1,2,3,4,5] Nutritional intervention for undernourished children can improve cognitive outcomes,[19, 20] but the long-term implications of not intervening are well documented.[1, 2, 3, 4, 5, 6, 7, 8, 9, 10] The critical first step in intervention is identifying those who are malnourished.

The impact of malnutrition on academic performance and executive functions is devastating for both the individual and the societies of Third World nations. Costello, et al, showed that specific nutrient deficiencies in childhood reduced the capacity for children to perform well in more advanced executive functions.[8] That is particularly concerning because it suggests that malnutrition causes individuals to lack the ability to reason and assume positions of responsibility. These deficits were noted in children deficient in specific nutrients; the effect will undoubtedly be compounded in more severely malnourished children. Omand, et al, make a strong case for the role of borderline nutrition and poor academic performance in Canada.[9] They did not even measure MUAC (mid-upper arm circumference) because their population would be unlikely to have any children who would be labelled malnourished by that screening method, but they showed convincing evidence that poor nutrition in that population had substantial and persistent negative effects on academic performance. Ivanovic, et al, showed that early childhood malnutrition in Chili was associated with lower IQ.[7] As the science evolves, even subtle forms of malnutrition have been shown to have profound detrimental effects. Given that knowledge, it is imperative that we identify those children placed at the greatest risk for inadequate brain development, lowered IQ, and depressed executive function because failure to identify those children will result in a lost opportunity to intervene on their behalf; they will become a drain on their already impoverished nations rather than productive citizens.

We noted that children between 36 and 60 months were at the highest risk of being missed when utilizing 12.5 cm as the cutoff for malnutrition in children from 6 to 60 months.[17] That group is of particular importance because of usual feeding practices in developing nations. Exclusive or predominant breast feeding is the norm in South Sudan and many developing countries for the first 1.5 to 2 years of life. Those children with the greatest risk for significant malnutrition face an increased challenge with the cessation of breast feeding. Children from 36 to 60 months are also preparing to enter formal education. Therefore, the unfortunate situation arises that children preparing to enter school are both at the greatest risk for malnutrition and are more likely to be missed utilizing current screening methods.

The question arises as to why a MUAC of 12.5 cm has become the standard screening cutoff for children under 5. Remembering that a screening tool should capture all who are at risk, using a cutoff at the lower end of the scale is inappropriate. We published a table of norms for age for MUAC[16,17] derived from earlier publications[18] because we found that data difficult to find. Utilizing that data, we found that a MUAC of 12.5 cm is -2 SD for boys at 12 months and slightly older for girls. On the other hand, a MUAC of 14 cm is -2 SD for both sexes at 60 months. As we consider the current standard, it is utterly illogical to use the measurement at the lower end of the scale—an adequate screen for an infant just starting to walk—to screen for malnutrition in children preparing to attend school.

The origin appears to have been a WFP (World Food Programme) grant targeting pregnant and lactating women. Yes, the target population included children between 6 and 60 months, but the program was primarily aimed at pregnant women and those with inadequate lactation. In defense of WFP, there is no indication that they sought to establish the cutoff at 12.5 cm for children under 5 years, but that standard has been adopted worldwide as the normal screening cutoff for children up to 60 months of age. With the available knowledge concerning both the inadequacy of the currently used MUAC standard and the long-term cognitive damage from malnutrition, a MUAC of 12.5 cm should no longer be the standard used for screening children from 6-60 months of age.

## CONCLUSION

It is critical that a more appropriate standard be used to screen for malnutrition in the developing world. Why is it vitally important to make this change? The most obvious reason is that many children with malnutrition have been and will continue to be missed using the current screening tool. In Africa and many Third World countries, breast-feeding is not only the best form of nutrition for infants; it is the critical source of nutrition in the first two years of life.[19] In the more nutritionally vulnerable populations, the child

faces increased vulnerability to malnutrition at the cessation of breast-feeding because the still rapidly growing child has lost the most important source of calories. That reality makes children from 24 to 60 months of age the most vulnerable population for malnutrition, but that is simultaneously the group most likely to be missed utilizing current standards. Moreover, those are the years of preparing for and initiating formal education. If those children are identified, appropriate nutritional intervention becomes possible as these children prepare to enter school. There is encouraging data to suggest that appropriate intervention can improve neurodevelopmental outcomes.[20] Given the information we have regarding the critical role of nutrition in brain development and the ability of a child to learn higher executive functions, this window of opportunity must be utilized if we are going to give these vulnerable children a chance to move out of poverty.

The development of third-world countries is a complex endeavor. Countries such as South Sudan need governments that support their people, infrastructure that allows and encourages economic growth, medical systems that can improve overall health, and schools that can educate all the children, boys and girls. But the most cost-effective and critical first step in enabling those countries to progress is to identify and intervene for the nutritionally vulnerable children. That begins with using the appropriate screening tool to identify undernourished children.

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