Publisher Name: MKS Publication
Editorial Book: Healthcare and Medicine
ISBN: 978-81-994361-3-8

Chapter 1

An Appropriate Nutritional Screening Method is a Critical Step for Third World Country Development

J. Clarke McIntosh[1*] **and Emmanuel Gai**[2]

[1] *Medical consultant Akot Medical Center, Akot, South Sudan.*
[2] *Clinical officer Akot Medical Center, Akot, South Sudan.*
[*] *Corresponding Author*

Abstract

Though obesity is the leading form of malnutrition in the world, undernutrition remains a critical concern in the developing world, particularly in sub-Saharan Africa. In earlier decades, the main focus of nutritional support was to reduce the risk for infections and death, but for the last three decades, greater understanding has emerged regarding the risk for permanent damage to brain development, cognition, and academic achievement posed by undernutrition during infancy and early childhood. This increases the pressure to identify and intervene on children with acute and chronic malnutrition. With respect to the practical issues of national development for third world countries, these issues may present harsher obstacles to the goal of rising out of poverty than the risks for infections and death by burdening these countries with substantial percentage of their populations unable to reach their genetic potential for intellectual development. In addition to a brief review of these issues, we review data from previous studies that demonstrate the harsh reality that the screening program used in virtually all low and middle income countries (LMIC) fails to identify large swaths of the population at risk for permanent brain damage, cognitive suppression, and poor academic performance caused by malnutrition in formative years. We recommend the abandonment of that insufficient screening tool and the immediate adoption of 14 cm as a more appropriate screening tool.

Keywords: Malnutrition, Undernutrition, MUAC, Screening, Intellectual development, School performance.

1. Introduction

The link between inadequate nutrition during infancy and early childhood with diminished brain development and poor academic performance is well established as an independent risk factor [1-8, 10]. More recent data examines the effect of subtle malnutrition in the early years and subsequent academic deficiencies in first world countries; the impact has been revealing in both the degree of deficits and the permanence of these detrimental effects. Omand, et al, make a strong case for the role of borderline nutrition and poor academic performance in Canada [9], though few if any of their subjects would be considered malnourished by LMIC standards. They did not even measure MUAC (mid-upper arm circumference) because their population would be unlikely to have any children 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. Costello, et al, showed that specific nutrient deficiencies in childhood reduced the capacity for children to perform well in more advanced executive functions [8], skills greatly needed in third world countries seeking to emerge from generational poverty. Ivanovic, et al, showed that early childhood malnutrition in Chili was associated with lower IQ [7] when compared to culturally similar cohorts without malnutrition.

The loss of these higher intellectual functions has more potential negative impact on developing countries than the risk for disease and death. The greatest natural resource of any nation is its people. As cold as it may sound, the death of young children can be overcome by increased childbearing, and virtually all developing nations have far higher birthrates than first world countries. But the loss of IQ and decreased ability to perform higher executive functions means large groups of the population will be thwarted in their desire to achieve higher skills and participate in nation building. Instead of adding to the wealth and productivity of the nation, these permanently intellectually damaged young people become a burden for families, communities, and ultimately the developing nations. The two most critical steps

How To Cite: J.C. McIntosh, E. Gai. *An Appropriate Nutritional Screening Method is a Critical Step for Third World Country Development.* In. J.E. Anieche (Ed). Healthcare and Medicine. Pages 1-5, 2026. MKS Publication, India. ISBN: 978-81-994361-3-8

of nations supporting the development of a middle-class are achieving higher education and a stable infrastructure to provide economic opportunities [10]. Malnutrition in early childhood substantially inhibits achieving higher education [4,5,6].

In sub-Saharan Africa, the issues around malnutrition have primarily dealt with far grosser measures of well-being—death and susceptibility to infectious diseases. Of course, overcoming those deficits continues to be extremely important, but in 2026, the focus should be in preventing the deficiencies in academic performance.

2. Materials and Methods

We used AI generated databanks screening all available literature looking at two major questions. First, the relationship between undernutrition (malnutrition) and brain growth, cognitive development, and higher intellectual functions. Second, the comparison of currently used MUAC 12.5 cm with other measures of malnutrition, such as weight for height.

3. Results

The data linking inadequate nutrition to stunted brain growth and subsequent intellectual deficits is overwhelming. The detrimental effects have been clearly shown from LMIC in every continent. These effects continue to be significant even when controlling for other issues such as cultural norms, socioeconomic factors, school disruption, societal unrest. There is more data regarding the detrimental effects of insufficient nutrition in the first two years of life, but the detrimental effects in early childhood (3-5 years) have been clearly shown [1,5].

A recent review by Chirwa and Yambayamba out of Zambia critically evaluated this field [11]. The authors were looking at neurodevelopmental outcomes. Their findings were consistent with much of the quoted reviews, but they highlighted the effects of malnutrition on cognitive development and higher functioning, such as “increased inattentiveness, conduct problems, and emotional dysregulation among children who experienced early undernutrition [12]”. Sub-Saharan Africans are struggling to have adequate teaching environments to achieve better outcomes for their populations. The disruptive effects in overcrowded classrooms of having 20% of the students unable to cooperate because of unaddressed malnutrition is easily appreciated.

An interesting note from their study was that stunting was more associated with cognitive maldevelopment than wasting. To some degree, this makes sense, since stunting reflects more chronic malnutrition. But that puts most LMIC in a difficult situation, because stadiometers and accurate scales are not widely available. Another valid explanation for their findings is that the standard for wasting (MUAC 12.5 cm for children 6-60 months) is not sufficiently sensitive.

Chirwa and Yambayamba noted both the permanence and yet plasticity of the effects of adequate nutrition on cognitive development. Neuroimaging shows permanent changes can arise in malnourished children, but their persisting plasticity suggests that identifying the children at risk and intervening properly may mitigate some of the detrimental effects [12,13]. These studies give us hope that we can do more than just identify children condemned to cognitive underachievement.

Because of the overwhelming amount of data linking the loss of cognitive development and undernutrition, we concentrated our review on studies regarding the efficacy of the current utilized screening norm of 12.5 cm MUAC to identify malnutrition in children 6-60 months.

The table below was modified from data from Das, et al [18]. The authors generated their own MUAC norms for their population, a commendable but impractical approach for screening in developing countries. It is unclear to this author whether they used the minimum months or maximum for the years in their table. Their population median and -2SD values were clearly lower overall than either the de Onis or WHO data. They make the unsurprising declaration that median and -2SD values increased as the age of the children increased. Though the data for the boys in Das study was surprisingly low, the -2SD values for the girls in that study was quite close to the -2SD data for both sexes at 5 years, with 14.0 cm probably being the most logical choice to derive for a screening cutoff.

Table 1: MUAC norms

	de Onis (1997) boys	WHO (2007) boys	Das (2013) boys	de Onis (1997) girls	WHO (2007) girls	Das (2013) girls
2	-2SD 13.6 Med 16.2	-2SD 13.0 Med 15.2	-2SD 11.9 Med 13.3	-2SD 13.4 Med 16.0	-2SD 12.7 Med 14.9	-2SD 11.9 Med 13.0
3	-2SD 13.8 Med 16.6	-2SD 13.5 Med 15.7	-2SD 12.0 Med 13.4	-2SD 13.6 Med 16.4	-2SD 13.3 Med 15.6	-2SD 12.5 Med 13.6
4	-2SD 14.1 Med 17.0	-2SD 13.7 Med 16.1	-2SD 12.5 Med 14.0	-2SD 13.9 Med 16.8	-2SD 13.6 Med 16.8	-2SD 13.1 Med 14.2
5	-2SD 14.2 Med 17.4	-2SD 14.0 Med 16.5	-2SD 12.8 Med 14.3	-2SD 14.1 Med 17.4	-2SD 14.0 Med 16.9	-2SD 13.6 Med 14.7

In our field study in Maridi, South Sudan, 229 children enrolled in preschool classes in four different schools had MUAC measurements after obtaining permission from school officials. We used standard MUAC tapes provided by WHO, and there was one individual who did all the measuring (EM). There were obvious shortcomings in the design. The stated sex and age of the child was used—no verification was possible because of the lack of birth certificates. The ages were in years, not months. We used the table below and used for our definition of malnutrition (undernutrition) -2SD below the median for age.

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

*data derived from de Onis M, et al [16]

We found a false negative rate (children -2SD for age but missed using 12.5 cm as the cutoff) in children from 6 to 60 months to be 14.8%. Looking specifically at children preparing to enter formal education (between 3 and 5 years of age), the false negative rate was 19.6% [15]. The false positive rates using MUAC 14 cm for screening was 8.3% overall, and 7.6% in children over 3 years of age.

A particularly relevant study that addresses the issue is by Laillou [17]. In that study data collected from 11,818 Cambodian children was analyzed and compared to Weight for Height (WHZ) scores. In that study, the authors examined both severe and moderate malnutrition. Using WHZ scores -2SD below the mean, they identified 1254 children with moderate malnutrition. Using a MUAC of 12.5 cm, the tool was quite specific, misidentifying only 1.7%, but it was a terrible screening tool, as only 209 children of the malnourished children were identified, for a sensitivity of 16.7%. That was despite the fact that 45.7% were younger than 2 years of age, and over 75% were under 3. Given the trends we experienced [15], it is safe to conclude that the sensitivity of using MUAC of 12.5 cm would have been even poorer had a higher percentage of the children been from the older age groups.

Fiorentino, et al, presented similar data and showed that the use of a MUAC of 12.5 cm for older children was far worse than in younger children. Reviewing data from 14,157 Cambodian children and using -2SD WHZ as the accepted norm for malnutrition, they found the overall sensitivity of 12.5 cm for identifying malnutrition to be 24.3% for children under 4.9 years of age, and only 8.1% for children between 2 and 4.9 years. Using 11.5 cm (to identify severely malnourished children), the overall sensitivity was 8.6% and only 2.8% in children 2-4.9 years. Two older studies from the 1990's also called for a different screening tool standard [20, 21].

4. Discussion

Several questions arise from this review. First, is it worthwhile to distinguish between moderate and severe malnutrition? Malnutrition is clearly a risk factor for death [22], and severe malnutrition is probably more of a risk than moderate, but given the data we have on even mild nutritional deficits, should we feel reassured about a child with only moderate malnutrition? It is our contention that we should not. Second, given the permanent nature of the detriments induced by malnutrition in cognitive development, is it important to identify all children at risk? To evaluate the question, look at another screening program. In 1979, it was estimated to cost $11,800 to identify and treat a child with congenital hypothyroidism, but the overall savings were estimated at $105,000 per child identified because of the permanent detrimental effects of not identifying congenital hypothyroidism. Those were US children and the detrimental effects of congenital hypothyroidism are more profound than those of malnutrition, but the conclusion was that a proper screening program was cost-effective in the long run, though there are more upfront costs [23].

Screening programs are designed to identify all individuals at risk. The sensitivity of the test is the most important issue; specificity is a later issue. Whether the screening is for neonatal issues or later in life, the most critical first step is to capture all those who are affected with the understanding that false positives (normal individuals identified in the screening process who do not have the disease) will occur, but after the initial screen, those normal patients can be distinguished. A good example of this is in screening for people infected with HIV (human immunodeficiency virus). We use a two-step method, understanding that the first step may include false positives (those who do not have HIV), but virtually all those who are at a stage of their disease where they can be identified are captured. The true positives can be identified with a confirmatory test [12]. The same is true for neonatal screening programs such as for congenital hypothyroidism and cystic fibrosis. The net is cast wide in an attempt to include all affected children; the normal children initially identified are evaluated by more specific tests and dismissed when the investigators are certain that the child is not affected.

MUAC is a potentially great screening method for undernutrition in developing nations and virtually the only tool that can achieve widespread use in LMIC. The tapes are inexpensive; the methods are relatively simple and quickly taught. Other methods that work well in more developed countries are not readily available in LMIC. Accurate weighing scales and stadiometer measurement of height are widely available in the US, Europe, and the more advanced countries in Asia. Clinics have readily available charts for height, weight, and their ratio compared to age. Those methods of screening are too expensive to be widely utilized in much of the developing world where undernutrition is still prevalent; MUAC tapes can fill that void. The costs involved in creating new MUAC screening tapes would be manageable. The 8.3% false positive rate we encountered would require a second step screening, comparing age to MUAC norms. Those tables are available at WHO websites and would cost little to print and distribute. Moreover, those false positives are borderline nutritionally deprived and warrant closer follow-up.

We acknowledge that defining appropriate nutrition is challenging. 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 [13] and more specific measures of obesity are needed. There are problems with BMI. Muscular individuals will tend to have a higher BMI, and BMI responds slowly in people who increase their muscles and decrease their fat percentage, even though those are good things. But BMI remains a good screening tool. The most readily agreed upon measure of undernutrition is when an individual is two standard deviations below the mean for their age (-2SD), whether that is weight, height, or MUAC. The standard used for screening for malnutrition in virtually all third-world countries for children between 6 months and five years of age is a MUAC of 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 [1-5]. A just criticism of this paper is that much of the data is old. Though we agree, we would argue the established nature of these findings is precisely why this article is of significant importance and the recommendations need to be heeded. Five studies from different countries years ago demonstrated that using a MUAC of 12.5 cm to screen for malnutrition was not adequate [17-21]. Many of the studies showing the risk for permanent brain damage caused by insufficient nutrition in the developing years of a child are from the last century, but the demonstrably poor screening tool is still used universally in developing countries. That means that millions of children who are at risk for permanent cognitive deficits from inadequate nutrition have not even been identified as needing nutritional support. There is no question that international organizations dealing with nutrition face significant challenges today, mainly caused by war and despotic regimes, but choosing not to identify those children at risk is inappropriate. Before PEPFAR (President's Emergency Program for AIDS Relief), developed nations tended to turn a blind eye to the ravages of HIV in Africa. The assumption was that no meaningful intervention was possible, but PEPFAR has been one of the most successful programs of US intervention because President GW Bush and Secretary of State Condoleezza Rice chose to intervene. The HIV crisis in Africa had been known for over a decade, but Bush and Rice chose to no longer ignore the issue.

It is time for the nutrition community to face the reality that our screening standard for malnutrition in 6–60-month-old children is demonstrably inadequate. Another just recommendation about the paper is that before making such a significant change, the children identified using 12.5 cm vs 14 cm should be compared to Z scores using other methods. First, we would point out that such studies have been done (comparing MUAC to weight for height scores) and their recommendations continue to be ignored [17,19]. We believe the findings in those studies are particularly relevant to the question at hand. They presented data looking at moderate and severe malnutrition. Interestingly, when Laillou, et al [17] generated a ROC (Receiver-Operator Characteristics) curve, they concluded that 13.8 cm would be the best cutoff, remarkably close to the 14 cm cutoff we are recommending, though our recommendation was derived differently.

The third question that then arises is, how much data is needed to make this substantial change? Though we are making this argument, the data from Laillou and Forentino make a much more compelling case. It seems apparent that no definitive study was done when the current standard of 12.5 cm was adopted as a screening tool. When one steps back from the issue, significant questions arise as to why a MUAC of 12.5 cm has become the standard screening cutoff for children under 5. An AI generated search suggests that the standard was initially used by UNICEF and WHO, but it is unable to find any study from which the figure was derived. Though a MUAC of 12.5 cm has been incorporated worldwide, it seems more appropriate to adopt a cutoff at the higher end of the scale than at the lower end. A MUAC of 14 cm is -2SD for 60-month-old children; 12.5 cm is -2SD for boys at 12 months and girls 24 months of age.

Given the combined knowledge of the inadequacy of the current screening tool and the critical importance of adequate nutrition in those ages, it seems imperative that we no longer delay the implementation of the more appropriate screening tool. If we fail to identify those children at the greatest risk for poor academic performance based on nutrition, the result will be a lost opportunity to intervene on their behalf. 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. That group is of particular importance because of usual feeding practices in developing nations. In Africa and many LMIC, breast-feeding is not only the best form of nutrition for infants; it is the critical source for calories and nutrients in the first two years of life [24]. In the more nutritionally challenged populations, the child becomes more vulnerable to malnutrition at the cessation of breast-feeding because the rapidly growing child has lost the most important source of calories. That makes children from 24 to 60 months of age the most vulnerable population for malnutrition, but that is the group most likely to be missed utilizing current standards [19]. Therefore, the unfortunate situation arises that children preparing to enter school are both at the greatest risk for malnutrition and are the most likely to be missed utilizing current screening methods. Any screening method, particularly for critical health issues, that misses 70% of the affected individuals [17,19] is a poor screening tool. If those children are identified, appropriate nutritional intervention becomes possible as these children prepare to enter school. There are encouraging data to suggest that appropriate intervention at that point can improve neurodevelopmental outcomes [25]. 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 LMIC 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.

References

[1] Sigman, M, Neumann, C, Baksh, M, et al. (1989) Relationship between nutrition and development in Kenyan toddlers. J Pediatr 115, 357–364.CrossRefGoogle ScholarPubMed.

[2] Freeman, HE, Klein, RE, Kagan, J, et al. (1977) Relations between nutrition and cognition in rural Guatemala. Am J Public Health 67, 233–239.CrossRefGoogle ScholarPubMed.

[3] Whaley, SE, Sigman, M, Espinosa, MP, et al. (1998) Infant predictors of cognitive development in an undernourished Kenyan population. J Dev Behav Pediatr 19, 169–177.CrossRefGoogle Scholar.

[4] Powell, C & Grantham-McGregor, SM (1980) The associations between nutritional status, school achievement and school attendance in twelve-year-old children at a Jamaican school. West Indian Med J 29, 247–253.Google Scholar.

[5] Sigman, M, Neumann, C, Jansen, AA, et al. (1989) Cognitive abilities of Kenyan children in relation to nutrition, family characteristics, and education. Child Dev 60, 1463–1474.CrossRefGoogle ScholarPubMed.

[6] Johnston, FE, Low, SM, de Baessa, Y, et al. (1987) Interaction of nutritional and socioeconomic status as determinants of cognitive development in disadvantaged urban Guatemalan children. Am J Phys Anthropol 73, 501–506.CrossRefGoogle ScholarPubMed.

[7] Ivanovic DM, Leiva BP, Pérez HT, Almagià AF, Toro TD, Urrutia M, Inzunza NB, Bosch EO. Nutritional status, brain development and scholastic achievement of Chilean high-school graduates from high and low intellectual quotient and socio-economic status. Br J Nutr. 2002 Jan;87(1):81-92. doi: 10.1079/bjn2001485. PMID: 11895316.

[8] Costello SE, Geiser E, Schneider N. Nutrients for executive function development and related brain connectivity in school-aged children. Nutr Rev. 2021 Nov 10;79(12):1293-1306. doi: 10.1093/nutrit/nuaa134. PMID: 33355357.

[9] Omand JA, Janus M, Maguire JL, Parkin PC, Aglipay M, Randall Simpson J, Keown-Stoneman CDG, Duku E, Reid-Westoby C, Birken CS. Nutritional Risk in Early Childhood and School Readiness. J Nutr. 2021 Dec 3;151(12):3811-3819. doi: 10.1093/jn/nxab307. PMID: 34587245.

[10] Sanchez A, Favara M, Sheridan M, Behrman J. Does early nutrition predict cognitive skills during later childhood? Evidence from two developing countries. World Dev. (2024) 176:106480. doi: 10.1016/j.worlddev.2023.106480.

[11] Chirwa E, Yambayamba KES. “Neuropsychological Consequences of Early Childhood Malnutrition in Zambia and Sub-Saharan Africa.” Academia Neuroscience and Brain Research, vol. 2, no. 1, Academia.edu Journals, 2026, doi:10.20935/AcadNeurosci8155.

[12] Kirolos A, Goyheneix M, Kalmus Eliasz M, Chisala M, Lissauer S, Gladstone M, et al. Neurodevelopmental, cognitive, behavioural and mental health impairments following childhood malnutrition: a systematic review. BMJ Global Health. 2022;7:e009330. https://doi.org/10.1136/bmjgh-2022-009330.

[13] Galler JR, Bringas-Vega ML, Tang Q, Robinowitz AR, Musa KI, Chai W, et al. Neurodevelopmental effects of childhood malnutrition: a neuroimaging perspective. Neuroimage. 2021.231:117828. doi: 10.1016/j.neuroimage.2021.117828.

[14] International Monetary Fund. African Dept. (2015). Driving Factors of Middle Class’ Bulge: A Cross-Country View1. IMF Staff Country Reports, 2015(064), A008. https://doi.org/10.5089/9781498323789.002.A008.

[15] Huang Y, Liu H, Dai S, Lan X, Liu S, Ren X, Huang C, Li X, Hong G. Evaluation of a two-test strategy for HIV screening in a low-prevalence setting and the indications for optimizing clinical management. Heliyon. 2023 Aug 23;9(9):e19400. doi: 10.1016/j.heliyon.2023.e19400. PMID: 37681153; PMCID: PMC10481286.

[16] Kranjac AW, Kranjac D. Explaining adult obesity, severe obesity, and BMI: Five decades of change. Heliyon. 2023 May 19;9(5):e16210. doi: 10.1016/j.heliyon.2023.e16210. PMID: 37251838; PMCID: PMC10213181.

[17] McIntosh JC, Gai E 2025. It’s Past Time to Change Mid-upper Arm Circumference (MUAC) Standards. Medical Research Archives, [online] 13(9). https://doi.org/10.18103/mra.v13i9.6825.

[18] Gai E, McIntosh JC. Inadequacy of a 12.5 cm MUAC as a cutoff for malnutrition for children aged three to five years, South Sudan Medical Journal, 2024;17(2):50-54.

[19] de Onis M, Yip R & Mei Z. The development of MUAC-for-age reference data recommended by a WHO Expert Committee. Bull. World Health Organ 75:11-18. Article in Bulletin of the World Health Organization • January 1997.

[20] Laillou A, Prak S, deGroot R, Whitney S, Conkle J. Optimal Screening of Children with Acute Malnutrition Requires a Change in Current WHO Guidelines as MUAC and WHZ Identify Different Patient Groups. PLoS ONE 2014; 9(7): 1-7 e101159.doi:10.1371/journal.pone.0101159.

[21] Das S, Banik SD and Bose K. Mid-upper arm circumference for age and undernutrition among 2 to 6 year old Bauri and Santal children of Purulia, West Bengal, India. Hum Bio Rev 2013: 2 (4), 359-372.

[22] Fiorentino M, Sophonneary P, Laillou A, Whitney S, de Groot R, Perignon M, et al. Current MUAC Cut-Offs to Screen for Acute Malnutrition Need to Be Adapted to Gender and Age: The Example of Cambodia. PLoS ONE 2016; 11(2): e0146442. doi:10.1371/journal.pone.0146442.

[23] Hall G., Chowdhury S., and Bloem M., ”Use of mid-upper-arm circumference Z scores in nutritional assessment,” Lancet, vol. 341, p. 1481, June 5 1993. [DOI] [PubMed] [Google Scholar].

[24] Hop le T., Gross R., Sastroamidjojo S., Giay T., and Schultink W., ”Mid-upper-arm circumference development and its validity in assessment of undernutrition,” Asia Pac J Clin Nutr, vol. 7, pp. 65–9, March 1998. [PubMed] [Google Scholar].

[25] Nangalu R, Pooni PA, Bhargav S, Bains HS. Impact of malnutrition on pediatric risk of mortality score and outcome in Pediatric Intensive Care Unit. Indian J Crit Care Med. 2016 Jul;20(7):385-90. doi: 10.4103/0972-5229.186218. PMID: 27555691; PMCID: PMC4968059.