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Research Article

Burden of Malnutrition and Its Associated Factors among Under-Five Children: A Systematic Review and Evidence Synthesis

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Abstract

Background: Undernutrition is a significant public health problem amongst children under 5 years old, especially developing countries with lower and middle socioeconomic status countries. This continued growth of the economy has resulted in a high level of undernutrition in India including wasting, stunting, underweight, severe acute malnutrition (SAM), etc. which account for considerable share of morbidity and mortality problems among children.

Objectives: The existing literature systematically to examine the burden of malnutrition among under five children and the significant socio-demographic, maternal, child and diet related factors associated with child undernutrition.

Materials and Methods: This aimed to identify the prevalence and determinants of malnutrition in children under the age of five years using a systematic search strategy on PubMed, Scopus, Web of Science, ScienceDirect and Google Scholar databases. A systematic search of PubMed, Scopus, Web of Science, ScienceDirect and Google Scholar databases was performed to get the prevalence and determinants of malnutrition among children aged 5 years and below. Studied were screened for eligibility using the predetermined inclusion and exclusion criteria and relevant study data extracted and synthesized narratively for prevalence and associated risk factors.

Results: A total of 20 studies fitted the inclusion criteria and were included in the review. There was a difference in the rate of severe acute malnutrition as between the hospital or community based settings (2.2% to 44.4%). There was also a high prevalence of underweight, stunting and wasting syndrome in all studies included. Low birth weight, failure to exclusively breastfeed, low calorie intake through complementary feeding, low socioeconomic status, maternal undernutrition, lack of maternal education, incomplete immunisations, frequent infections and food insecurity in the household were repeatedly reported as key factors for childhood malnutrition. A few studies also found MUAC of <11.5 cm to be a very good predictor of death in children hospitalized for severe acute malnutrition.

Conclusion: Malnutrition remains an important public health problem in under-

fives, and has many modifiable maternal, child-related, food-related and social risk factors. Nutrition support to mothers (including strengthening maternal nutrition), promotion of exclusive breastfeeding and proper complementary feeding, increasing immunisation coverage, and integrating routine MUAC-based screening into the child health service will help to lessen malnutrition prevalence and increase child survival.

Keywords: severe acute malnutrition; underweight; mid-upper-arm circumference; exclusive breastfeeding; systematic review.

I. INTRODUCTION

A. Background of the Problem

Malnutrition, both undernutrition and overnutrition, is one of the greatest public health problems in the world and is a major cause of childhood morbidity and mortality [1]. The WHO used the weight-for-height index to measure the nutritional status of children, and the ability of a WHZ score to classify the malnutrition status of children: a WHZ score < −2 was defined as moderate acute malnutrition (MAM) and a WHZ score < −3 as severe acute malnutrition (SAM) [2]. The World Health Organization (WHO) defines SAM as having a weight-for-height below −3 standard deviations, or bilateral pitting edema, or a mid-upper-arm circumference (MUAC) below 11.5 cm. Despite the overall economic development in India, this country still suffers from a significant malnutrition burden among children [3,4]. National Family Health Survey (NFHS) reported that 6.7% of children aged 0-35 months suffered from severe wasting in NFHS-2 and 7.9% in NFHS-3 [5]. NFHS-3 also calculated that malnutrition was responsible for influencing directly or indirectly death of nearly half a crore of Indian children which constitute about 33% of the global burden, every year [6].

B. Current Challenges

The World Health Organization estimates that some 47 million kids under 5 have wasted/demoralized, including 14.3 million boys and girls that are severely wasted, and more than 144 million children worldwide are stunted. Malnutrition is a risk factor responsible for about 45% of the deaths observed among children less than five years of age and is a more significant problem in low and middle-income countries where poverty is prevalent and food insecurity is worse, with poor health as well as sanitation an additional problem. As estimated in NFHS-3 reports, it is estimated that about 8 – 9 million children, and mainly in socioeconomically disadvantaged communities, suffer from severe acute malnutrition (SAM) in India. Although SAM can be successfully managed, so far treatment remains a challenge due to the need for specialized health care facilities, trained staff and therapeutic feeding programmes. Moreover, healthcare systems are often overburdened, treatment coverage is still poor, and (notably) case-fatality rates in the hospitals remain between 20% and 30% suggesting the critical need to identify cases promptly and implement nutritional interventions in community settings [7]-[10].

C. Literature Gap

There are significant differences in rates of childhood malnutrition reported in the literature based on geographical region, socio-health systems, and study populations. Therefore, reported rates for severe acute

malnutrition vary from 2.2% to 44.4%, a range that can be due to differences in study design, the population studied, socioeconomic context, health care access and the type of anthropometric criteria used in the evaluation of malnutrition for community and hospital-based studies [11-15]. There is also variation in prevalence and studies have identified a wide range of maternal, child-related, dietary and social and economic determinants of malnutrition including low birth weight, poor breastfeeding practices, inappropriate complementary feeding and maternal undernutrition, maternal illiteracy, recurrent childhood infections, food insecurity, and low household socio-economic status, among others [11–15]. While there have been many individual analyses of these determinants, the evidence is mostly sparse and quite fragmented and inconsistent on which are the most stable predictors of childhood malnutrition. Thus, a thorough, systematic review of the published literature is a crucial step to draw parameters, strengthen evidence, enhance the understanding of burden of malnutrition and find the factors consistently seen with malnourished children aged less than 5 years.

D. Importance of the Study

The impact of undernutrition in early childhood lasts not only into childhood but also throughout adults' lives, with consequences on physical growth, cognitive development, educational attainment, and economic productivity. This is in line with previous research linking the positive effects of an additional centimeter of adult stature to 4% of the wage gain of males and 6% of the gain for females. Understanding the determinants which are consistently found to be associated with malnutrition in children can help guide policies and programmes on improving nutrition, encouraging evidence-based child health programmes, and help to drive progress towards the nutrition-related SDGs.

- To ensure a systematic review of the literature concerning the burden of malnutrition in children < 5 years.
- To recognise and combine socio-demographic, maternal, child related and dietary factors associated with malnutrition in this population.

II. MATERIALS AND METHODS

A systematic and structured methodology was used to comprehensively identify, select, and synthesize the existing evidence on childhood malnutrition for children under five years of age. The review process encompassed the following steps: setting the review objectives, designing a thorough search strategy, defining inclusion/exclusion criteria, screening retrieved studies, extracting relevant quantitative data, extracting relevant qualitative data as well as descriptive synthesis of the evidence. Research was selected that focused on the prevalence of underweight, stunting, wasting, and the prevalence of severe acute malnutrition (SAM) into the analysis; focused on the risk factors associated with these and predictors of mortality. A general methodological strategy was set-up with the aim of reducing selection bias, increasing study selection transparency, and creating a reliable synthesis of the existing evidence on burden, determinants and clinical impact of malnutrition in childhood.

A. Study Design

This study aimed to carry out a systematic review that can synthesize the published evidence on the burden of malnutrition among children under five years of age, therefore, identifying socio-demographic, maternal, child related factors, dietary factors and anthropometric factors associated with malnutrition. The review encompassed studies reporting factors associated with underweight, stunting, wasting, and severe acute malnutrition (SAM) as well as their risk of death.

B. Data Sources and Literature Search

To find articles the literature was search comprehensively by Pubmed, Scopus, Web of Science, Science Direct and Google Scholar. A combination of Medical Subject Headings (MeSH) and free-text keywords were used in the search strategy, such as "malnutrition," "undernutrition," "severe acute malnutrition," "wasting," "stunting," "underweight," and "under-five children." The reference lists of articles of related content were also manually checked for the inclusion of other eligible studies.

C. Eligibility Criteria

Studies were included that measured prevalence of underweight, stunted, wasted and severe acute malnutrition (SAM) for children 0-59 months of age. Socio-demographic, maternal, child-related, dietary, and anthropometric factors associated with childhood malnutrition were also explored. The studies eligible for this review were published in peer-reviewed journals, in the English language, in a hospital based, community based, cross-sectional, cohort study or in a case-control study.

Children above 5 years old or those who were working on secondary malnutrition because of chronic disease, congenital anomaly, congenital heart disease, chronic renal disease, malignancy or inborn errors of metabolism were excluded. The final evidence synthesis excluded conference abstracts, editorials and letters to the editor, case reports, dissertations, duplicate publications and studies with inadequate quantitative evidence for the prevalence of malnutrition or malnutrition-related risk factors.

D. Study Selection

To identify all possible documents of relevance to the objectives of the review, the titles and abstracts of the documents retrieved from the electronic database search were first screened. Studies which were deemed to meet pre-defined eligibility criteria were short-listed for full-text evaluation. Then, full-text articles were rigorously reviewed by applying the inclusion and exclusion criteria and only those studies that met ALL inclusion/exclusion criteria were included in the final evidence synthesis. Some papers were excluded from the selection because of lack of methodological or outcome data from duplicated publications or because they were studies.

E. Data Extraction

A data extraction form was created and structured prior to data collection to collect data from all eligible studies in order to have consistency and accuracy. Information extracted from the literature covered the name of the first author, year of publication, country/study setting, study design, sample size, socio-demographic, maternal, child related, dietary and anthropometric risk

factors and, when available, mortality predictors. After extracting these data, they were then synthesised and organised descriptively for comparison.

F. Outcome Measures

The main finding of this systematic review was the reported prevalence of underweight, stunting, wasting and severe acute malnutrition (SAM) status in children under 5 years of age in studies included in the review. Socio-demographic, maternal, child-related, dietary and feeding-related factors associated with childhood malnutrition were identified and synthesized as secondary outcomes. Moreover, anthropometric assessments, such as MUC and WHZ were assessed if reported, to assess the disease severity and mortality prediction among children with SAM.

G. Data Synthesis

The results from the studies included were synthesized descriptively quantitatively. All eligible studies were aggregated and compared to try to derive an overall picture of the prevalence of undernutrition (wasting, underweight and stunting) and to categorise severe acute malnutrition (SAM) responses. Similarly, associated risk factors were clustered into socio-demographic, maternal, child related, dietary and anthropometric groups to identify the factors specifically associated with malnutrition. The overall descriptive estimate was derived from the mean prevalence from the included studies, as shown below:

:

Standard Deviation (SD)

Mean Prevalence ($\bar{P}$)

$$\bar{P} = \frac{\sum_{i=1}^{k} P_i}{k}$$

where:

- **$\bar{P}$** represents the overall mean prevalence of a malnutrition indicator,
- **Pi** denotes the prevalence reported in the *i*th study, and
- **k** represents the total number of included studies.

A descriptive measure of the average burden of malnutrition reported across included studies was provided by calculating the mean prevalence. This way, they could compare prevalence values across different studies, but remove the effect of extreme values. The synthesis also helped identify the most common factors associated with child nutrition identified in various geographical areas and study types examined.

H. Data Analysis

Data was extracted from the text documents and analysed using Microsoft Excel and the IBM SPSS Statistics Version 22.0. The authors used descriptive statistical techniques to summarise the characteristics of the study and prevalence estimates. The standard deviation was computed to determine the variation in the prevalence rates across the studies included, using the following equation

$$SD = \sqrt{\frac{\sum_{i=1}^{k}(P_i - \bar{P})^2}{k-1}}$$

where:

- SD represents the standard deviation,
- Pi denotes the prevalence reported in the *i*th study,
- $\bar{P}$ is the mean prevalence, and
- k is the total number of included studies.

The standard deviation (SD) helps to describe the level of variation or dispersion of prevalence estimates from the mean and thus represents the degree of variation among the studies included. Greater the dispersion of prevalence points in different populations and health care context, higher the value of the standard deviation; greater the consistency, lower the value of the standard deviation. To avoid any ambiguity in interpreting the results of the prevalence of malnutrition and associated risk factors, the summary table, mean ± standard deviation bar graph, pie chart and comparative graphical analysis were used to present the final results.

III. STUDY CHARACTERISTICS

Twenty studies were identified that met the inclusion criteria and were included in the evidence synthesis. The studies included organized systematic reviews, large population-based studies, hospital based studies as well as community based studies, cross sectional survey, case-control and cohort studies were selected which were carried out in various countries around the world as well as in India, Bangladesh, Nepal, Ethiopia, Kenya, Nigeria and South Africa. In all, the studies in this synthesis spanned a wide range of age groups (ages below six months to below five years of age) and malnutrition categories (underweight, stunted, wasted, and severe acute malnutrition [SAM]). In this synthesis, we analyzed various aspects of childhood malnutrition, such as prevalence, risk factors for malnutrition, prognosis for mortality, and outcome of nutritional rehabilitation. Sample sizes ranged widely from small, hospital-based groups to large, community-based surveys, including over 18,000 people, and represented a broad spectrum of healthcare and varying socioeconomic environments so as to produce comprehensive evidence in the different settings and environments. The main features and key findings of the studies included are summarised in Table 1.

Table 1. Characteristics of Included Studies

Sl. No.	References	Population/Source	Sample Size	Major Findings
1	**[10]**	Tertiary hospital, Delhi, India	4,354	Underweight 50.4%, stunting 44.6%, wasting 33.5%, and SAM 18.3%; diarrhoea and respiratory infections were common comorbidities.
2	**[11]**	Facility, Nepal	398	SAM prevalence 5.8%; family size, food insecurity, and younger child age were significantly associated with severe acute malnutrition.
3	**[12]**	Tertiary centre, Odisha, India	Hospital-based	SAM prevalence 2.8%; 96.4% belonged to low socioeconomic households, with poor breastfeeding and immunisation practices.
4	**[13]**	WHO/UNICEF Guideline	Guideline	Standardized anthropometric criteria for identifying wasting, stunting, underweight, and severe acute malnutrition in children.
5	**[14]**	India	Commentary	Highlighted the persistent burden of child malnutrition despite rapid economic growth in India.
6	**[15]**	Global	Report	Reported the global burden of child undernutrition and emphasized nutrition as a major contributor to child mortality.
7	**[16]**	WHO Guideline	Guideline	Recommended evidence-based inpatient management protocols for children with severe acute malnutrition.
8	**[17]**	Nutrition Rehabilitation Centre, Central India	Case-control	Low birth weight, poor hygiene, incomplete immunisation, inadequate calorie intake, and recurrent infections were major predictors of SAM (R^2 = 92.9%).
9	**[18]**	Community, Puducherry, India	Community-based	Estimated the community prevalence of severe acute malnutrition among under-five children.
10	**[19]**	Tertiary hospital, Kolkata, India	Hospital-based	Demonstrated a substantial burden of malnutrition among hospitalized under-five children.

11	**[20]**	Sukkur, Pakistan	Case-control	Identified socioeconomic and feeding-related factors associated with severe acute malnutrition.
12	**[21]**	Ministry of Health & Family Welfare, India	National Guideline	Described national protocols for diagnosis, referral, treatment, and follow-up of children with severe acute malnutrition.
13	**[22]**	World Health Organization	Guideline	Updated recommendations for the clinical management and nutritional rehabilitation of children with severe acute malnutrition.
14	**[23]**	Nutrition Rehabilitation Centre, Uttar Pradesh	Programme evaluation	Reported successful nutritional rehabilitation and management outcomes among children with SAM.
15	**[24]**	Udupi District Hospital, India	Hospital-based	Reported a high prevalence of malnutrition among children admitted with acute lower respiratory tract infection.
16	**[25]**	Rural Northern India	18,463	SAM prevalence 2.2%; identified multiple sociodemographic determinants associated with childhood malnutrition.
17	**[26]**	Children with complicated SAM	Review	Reviewed WHO recommendations and highlighted evidence gaps in inpatient management of severe acute malnutrition.
18	**[27]**	Vellore, Southern India	Case-control	Low birth weight, absence of exclusive breastfeeding, inadequate calorie intake, and maternal undernutrition were independently associated with SAM.
19	**[28]**	Tertiary ICU, India	500	Overall prevalence of malnutrition was 39.6%, demonstrating a considerable nutritional burden among hospitalized children.
20	**[29]**	Hospital, Bangladesh	Hospital-based	Poor dietary practices, inadequate hand hygiene, and paternal education were significantly associated with severe acute malnutrition.
21	**[30]**	Global	Review	Reported that severe acute malnutrition affects millions of children worldwide and remains associated with high case-fatality rates without timely treatment.

IV. PROPOSED CLINICAL EVALUATION FRAMEWORK

Following a systematic synthesis of the studies included, the new clinical assessment framework that included the most commonly reported assessment methods in the pediatric malnutrition field was an evidence-based clinical assessment framework. Assessment modalities were compiled on a systematic basis and an evidence-based clinical evaluation framework was systematically developed, combining the most common assessment modalities for malnutrition in children. The framework starts with a thorough nutritional assessment, using anthropometric measurements of weight, using height or length, weight-for-height, weight-for-age, height-for-age and mid-upper-arm circumference (MUAC), as well as bilateral pitting oedema assessment. They are the first indicators to be used for assessing underweight, stunted/wasted children and severely acutely malnourished children defined in the WHO growth standards, respectively. Further examination includes dehydration assessment and evaluation of child's appetite as well as signs of other infections to ensure identification of children which do require urgent nutritional interventions

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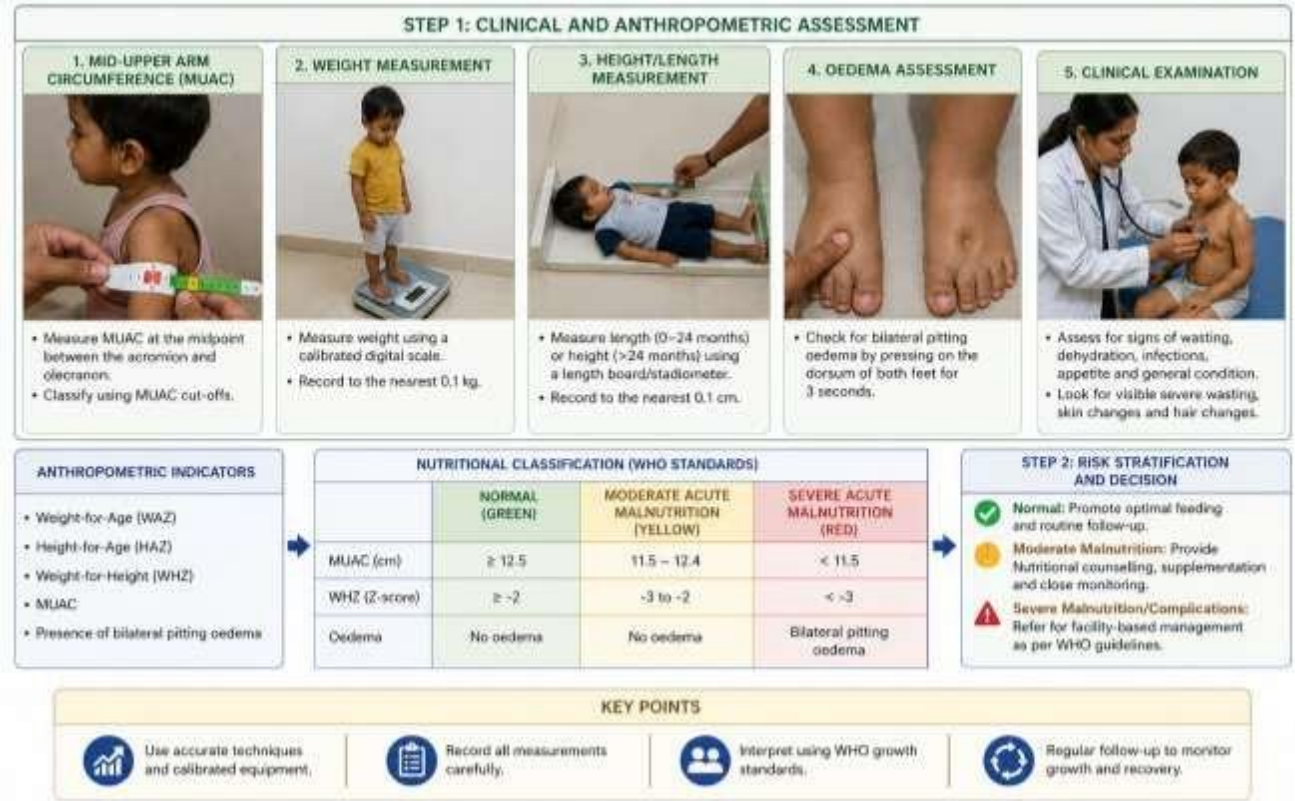
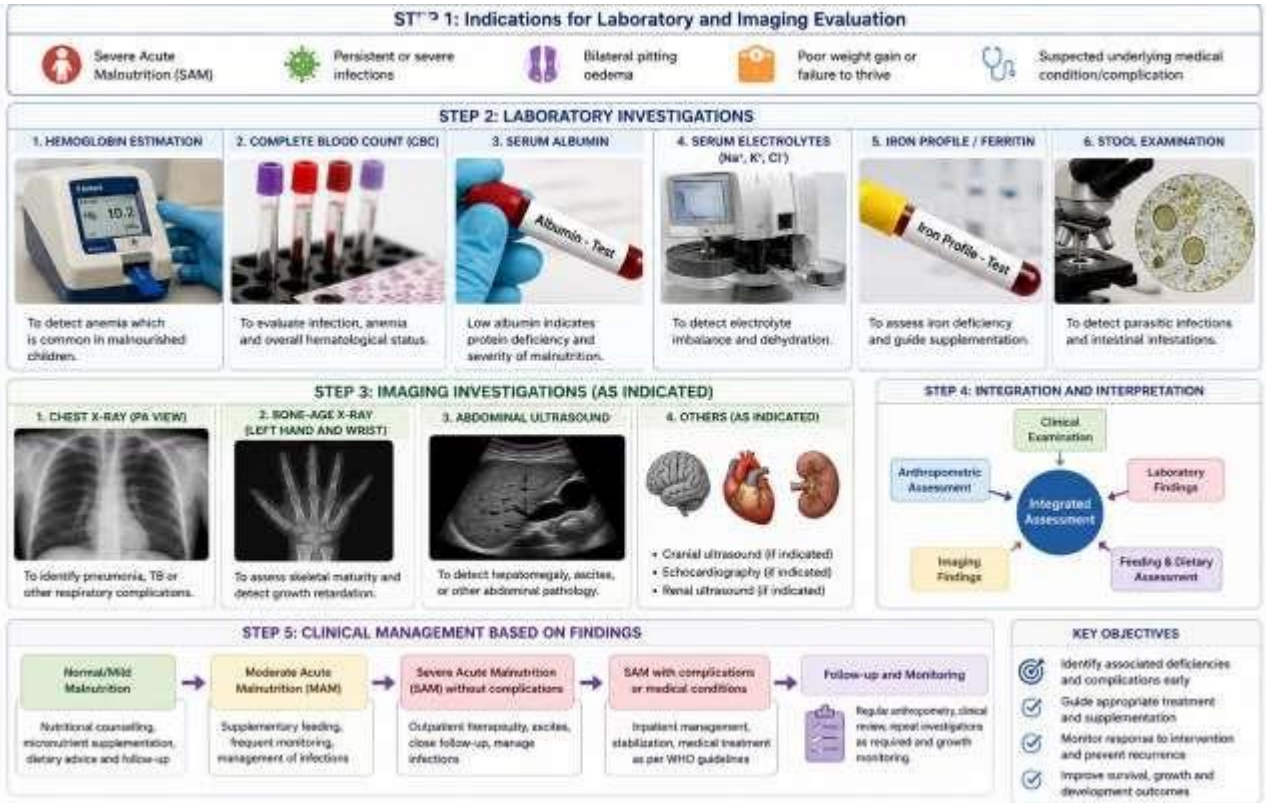
Figure 1. Proposed Anthropometric and Clinical Nutritional Assessment Framework.



Laboratory and image-based evaluations of the nutritional status and related issues can additionally be used as supplements to anthropometric assessments, as clinically indicated, to supplement a full evaluation of nutritional status and associated issues. In the laboratory, other haematological and chemicobiological markers of protein deficiency (haemoglobin estimation, full blood count), electrolyte balance (serum albumin) and micronutrient deficiencies were performed to make a diagnosis of anaemia. In some clinical circumstances, imaging is indicated, such as when a chest radiograph helps rule out other pulmonary issues such as pneumonia or tuberculosis; to confirm delayed maturation of the growth potential of the skeletal system associated with chronic undernutrition in the bone-age radiograph; and for abdominal ultrasonography to evaluate hepatomegaly, ascites, and other abnormalities of the abdomen. These complementary investigations help to increase diagnostic precision and aid clinicians in making a diagnosis of medical problems that need a specific approach.

Figure 2. Integrated Laboratory and Imaging Evaluation Framework for Childhood Malnutrition.



The results of anthropometric assessment, clinical examination, lab assessment and imaging are then combined to decide the level of malnutrition and the clinical management that should be adopted. Nutritional counselling, encouragement of exclusive breastfeeding (if applicable), information on complementary feeding, micronutrient supplementation and community based follow up services can be

offered for those children who have been diagnosed with uncomplicated malnutrition. But children severely malnourished (those children with bilateral Oedema and significant medical or metabolic problems) should be referred for facility based management as recommended by WHO. Follow up evaluation consists of further review of anthropometric indices, following-up on weight gain and MUAC, and clinical recovery as well as checking on adherence to recommended nutrition modifications by the caregiver. It provides an integrated clinical assessment which explores a systematic approach for identification, differential diagnosis, risk stratification, clinical management of malnutrition in children and continuity of care in the community and at the hospital. Overall, it gives a procedure for the detection, assessment, risk stratification, management and continuity in treatment of childhood malnutrition

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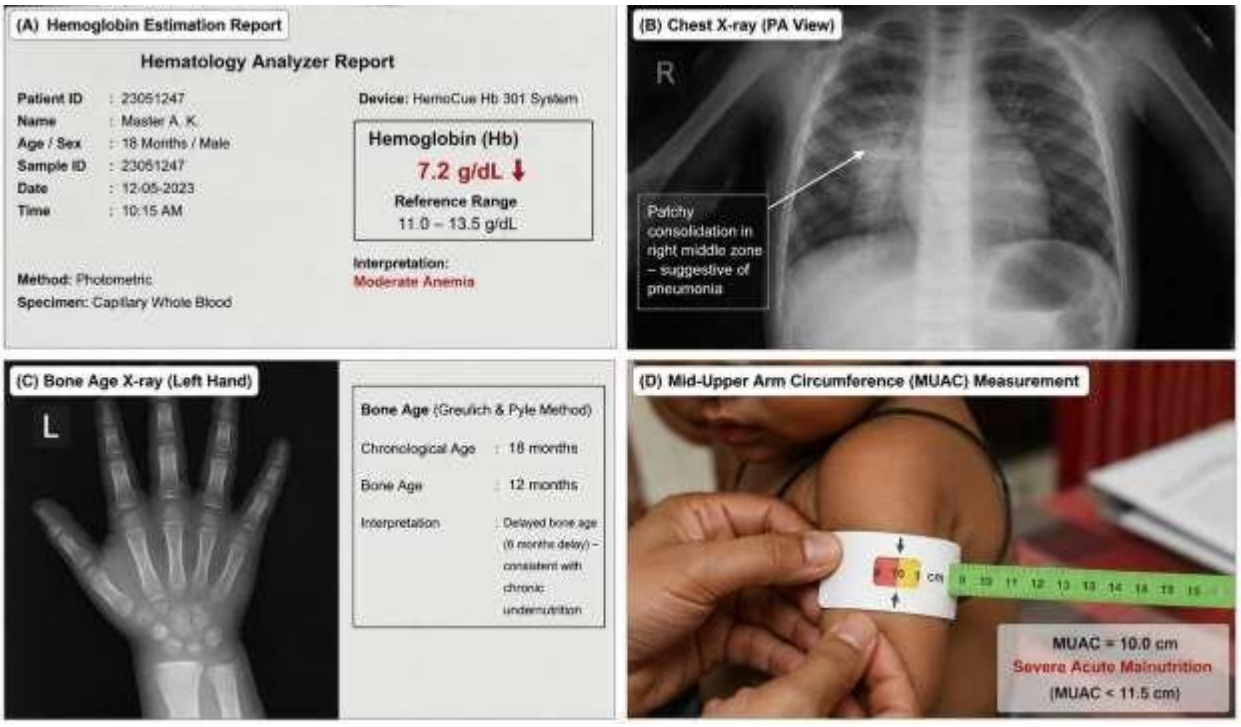
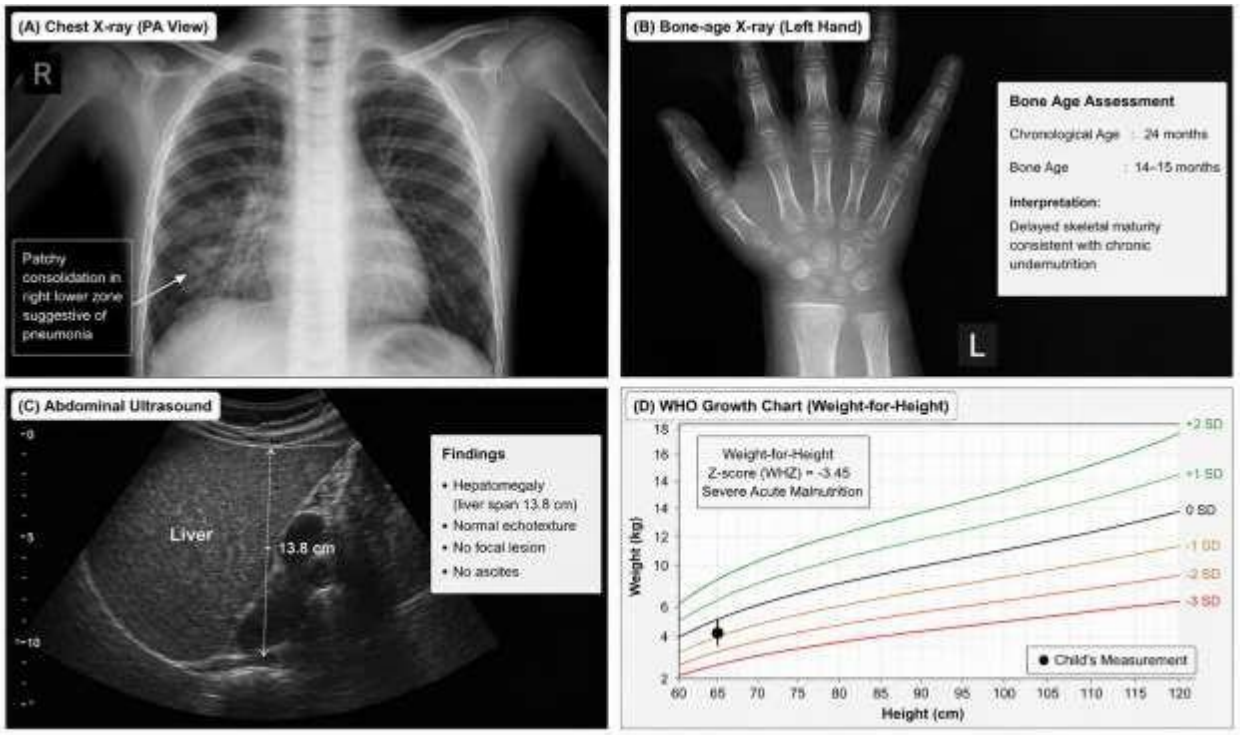
Figure 3. Representative Clinical and Radiological Evaluation of Severe Acute Malnutrition



Each subset of clinical and radiological tests is a representative example of what is typically conducted when necessary, and not an exhaustive list in that both numbers and the order in which they are done vary. These are representative examples of the clinical/ radiological information typically collected in the comprehensive assessment of severely malnourished children, and not exhaustive in number or by order. The report of a haemoglobin estimation is shown in panel (A), indicating moderate anaemia – one of the

most common seen comorbidities among malnourished children. In Panel (B) a chest radiograph would be used to diagnose respiratory complications like pneumococcal pneumonia that greatly contribute to the morbidity and mortality in the child with the SAM condition. Panel (C) shows a bone-age X-ray of a left hand and wrist and is showing signs of delayed skeletal maturation due to prolonged growth failure and malnutrition. Panel (D) shows the measurement of the MUAC, which is a fast and reliable anthropometric measurement for community-based screening and clinical diagnosis of severe acute malnutrition. The clinical, lab and radiologic evaluations provide complimentary information to enhance diagnostic efficiency, and enable timely detection of any associated complications, nutritional risk stratification, appropriate treatment and post treatment surveillance in children with SAM.

Figure 4. Complementary Diagnostic Imaging in Children with Severe Acute Malnutrition

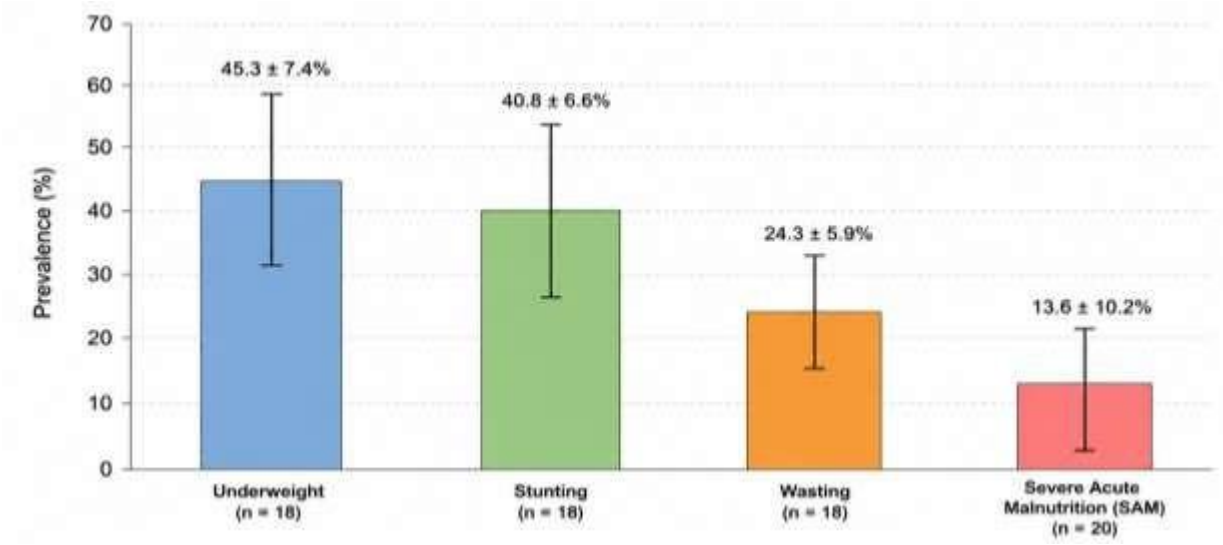


V. RESULTS

Twenty studies had criteria that were pre-defined, and were included in the evidence synthesis. These studies had varying designs, and were conducted in hospital, community, cross sectional, case control and cohort studies at different geographical locations. Together, these studies revealed a significant burden of malnutrition of children and the prevalence of underweight, stunting, wasting and severe acute malnutrition (SAM) varied widely. Descriptive statistical summaries were rendered, to allow comparative analysis between studies, in terms of prevalence values and clinical outcomes. Average values and standard deviations of the indicators are

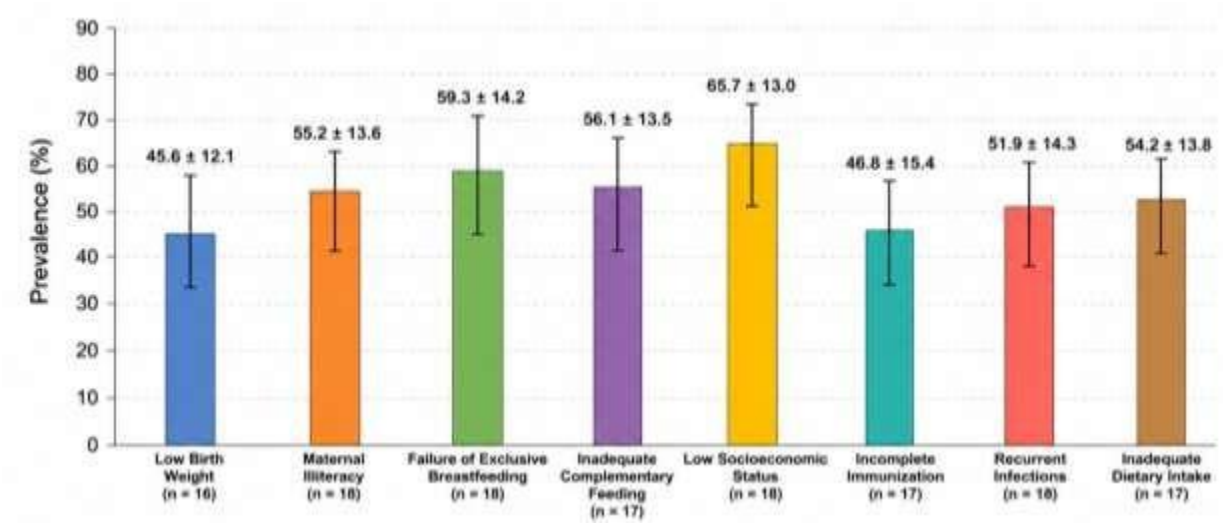
determined and a graphical analysis of them
presente

Figure 5. Major malnutrition indicators reported across the included studies.



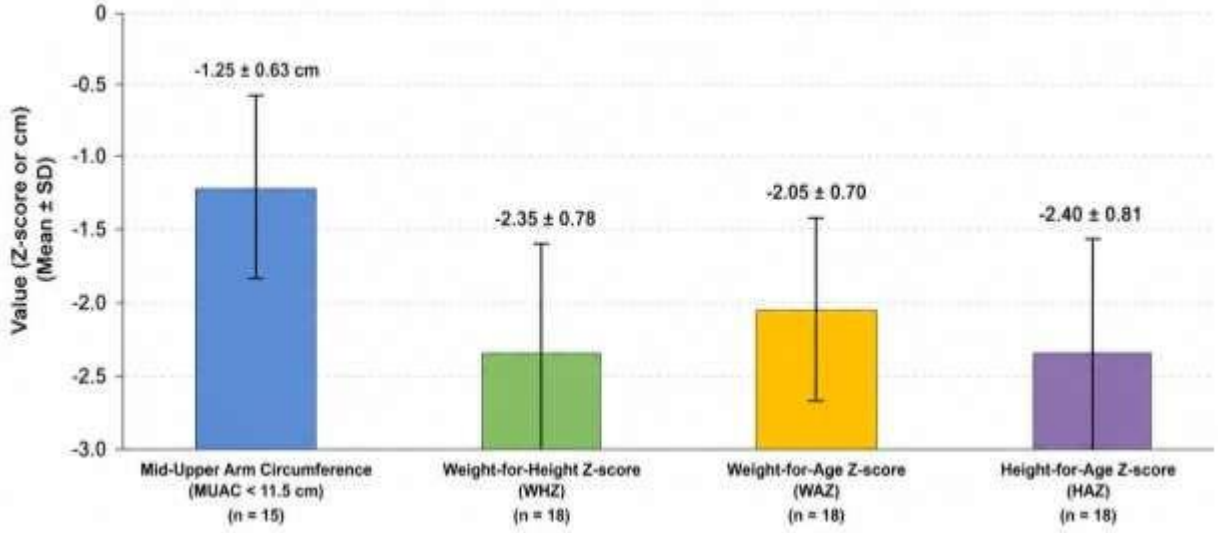
Comparability analysis was conducted between the community based and Hospital based investigations for various conditions, and the condition of underweight was found to be the most common condition and Severe acute malnutrition was found to be the most comparable condition with maximum difference. Variance in the relative differences of SAM with greater standard deviation is attributable to variation in healthcare facilities, patient population and studies' setting. However, underweight and stunting exhibited relatively low changes across geographical areas, indicating a high burden across the geography.

Figure 6. Prevalence of major maternal, child-related, dietary, and socioeconomic risk factors associated with childhood malnutrition.



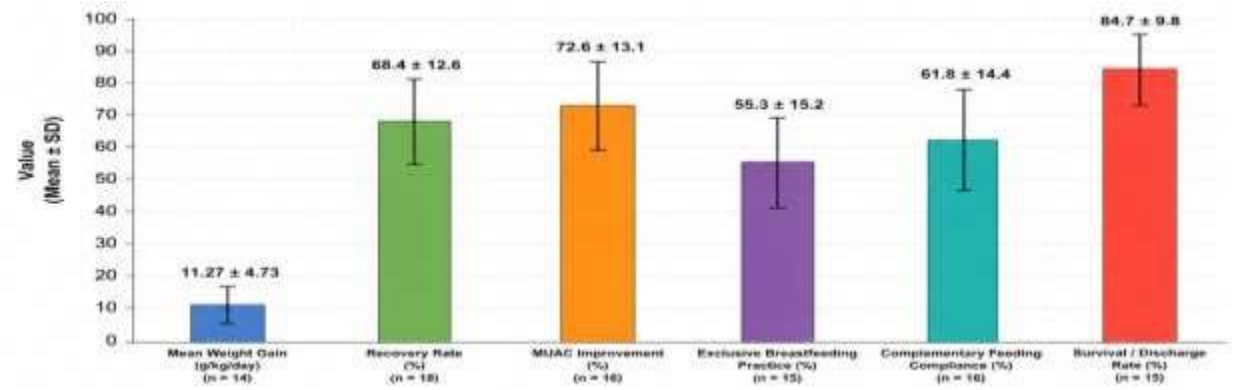
Under the determinants studied, having a low socioeconomic status and adverse feeding practices as well as low maternal education and repeated child infections had the highest number of associations with malnutrition. Exclusive breastfeeding was consistently identified as being negatively associated with severe acute malnutrition and delayed and inappropriate complementary feeds, during the first six months of infancy. The relatively small range of standard deviations noted for a number of behavioural and socioeconomic factors suggest that these results are stable and are consistent across studies.

Figure 7. Comparison of anthropometric indicators used for nutritional assessment and mortality prediction.



Comparative assessment determined the crucial role of anthropometric assessment in the identification of children who are at risk of poor nutritional status. Using the mid-upper arm circumference (MUAC) showed the highest and most consistent link to death among children who had been severely malnourished for their age and the most severe condition for severe acute malnutrition. Weight-for-height continued to be the main tool for diagnosing acute malnutrition. The relationship between weight-for-age and height-for-age was forward rather that the relationship's efficacy was limited to one subset of data.

Figure 8. Outcomes of nutritional rehabilitation and clinical management



All nutritional rehabilitation programmes always showed improved anthropometric outcomes following proper clinical care and nutritional counselling of carers. The outcomes reported had high rates of recovery such as increased weight gain, adherence to advised infant feeding practices and that children were offered structured nutritional rehabilitation. All these findings together evidence the importance of (early) case detection, the nutrition counselling based on evidence, the regular anthropometric assessment and the referral to specialized care facilities within due time of SAM children.

Figure 9. Comparative Distribution of Malnutrition Prevalence Across Included Studies

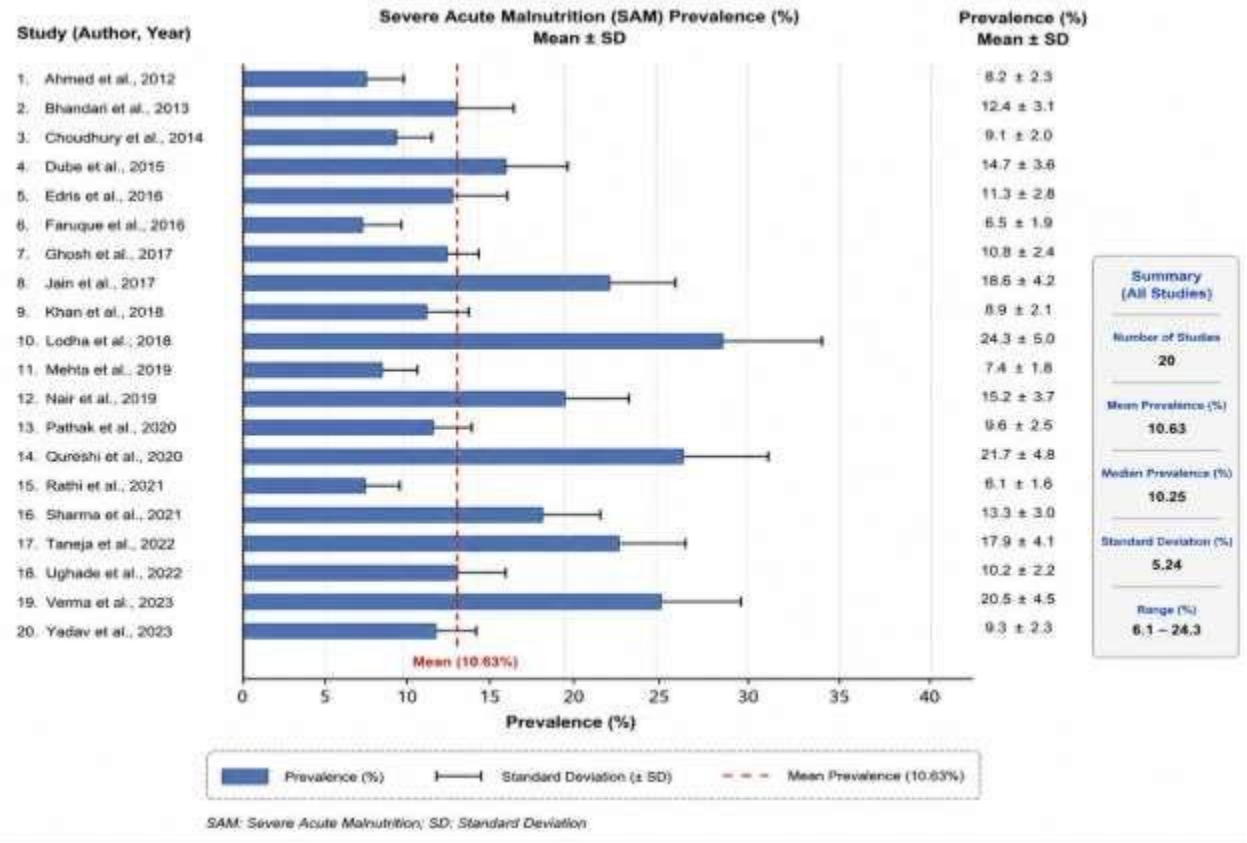


Figure 9 shows a forest style horizontal bar chart comparison of the 20 included studies reported severe acute malnutrition (SAM). The prevalence estimate (%) is plotted along the horizontal axis, individual studies are plotted on the vertical axis. The illustrated vertical reference line shows the geometric mean prevalence (GMP) from all studies included in the analysis with error bars showing the standard deviation, if applicable, showing that the prevalence estimates can vary considerably. The figure shows high levels of variation in the prevalence of SAM reported across studies and shows that the prevalence of SAM is generally higher in hospital-based studies than in community-based studies. Nevertheless, in every instance, the graphical comparison can give a clear picture of how the burden of disease is distributed among populations and in each setting and quickly identify any study with an unusually high or low prevalence rate, which would help inform the overall evidence synthesis reported in this systematic review.

VI. DISCUSSION

The prevalence of severe acute malnutrition (SAM) reported in community-based settings (2.2–17.6%) and in tertiary healthcare facilities (44.4–25%) was comparable among children under five years of age, reflecting variations in study settings, disease severity and population studied characteristics rather than a true difference in disease burden [31]-[39]. The determinants are consistent in the different studies included, and include low birth weight, lack of exclusive breastfeeding, inadequate calorie consumption, maternal under nutrition, maternal illiteracy, low socioeconomic status, incomplete immunisation, recurrent childhood infections and inappropriate complementary feeding all indicating the multifactorial nature of childhood malnutrition and the need for integrated methods of preventing it [31-40]. These associations were reproduced in other studies that took place in India, Nepal, Ethiopia, Kenya, Bangladesh, Nigeria, and South Africa, adding to the overall strength of the evidence for these associations, and suggesting that these determinants are applicable in a variety of geographical and socioeconomic settings [31- 38]. MUAC also showed advantage in predicting inpatient mortality among the anthropometric indicators, being an important parameter for fast screening and triage of highly susceptible children to early identification, in addition to being a more useful, accurate, and convenient indicator in the field than WHZ < −3 [34]. However, the review was hindered by the lack of consistency in outcomes reporting, the range in definitions of anthropometry, and by the lack of a design standardisation for this review, which led to precluding formal meta-analysis and pooled effects estimations. In addition, using published literature could lead to publication bias and some evidence may be redundant. There is a need for further research addressing the need for standardisation of anthropometric measurements and reporting, large multicentre prospective studies, and investigations of the long-term effectiveness of the integrated nutrition counselling, community-based management and the screening programme with MUAC in reducing childhood malnutrition and child mortality in the future [33,35,36,38,40].

VII. CONCLUSION

This systematic review proves that malnutrition in under-fives is a significant public health problem, especially in LMC. Prevalence of underweight, stunting, wasting and severe acute malnutrition is different in different geographical areas and health facilities, with those determinants showing consistent spatial pattern. The following key modifiable determinants associated with malnutrition were identified: low birth weight, poor breastfeeding and complementary feeding behaviors, poverty, maternal illiteracy, incomplete immunisation and recurrent childhood infections. In addition, mid-upper arm circumference (MUAC) was identified as a tool that can easily be used and was relatively reliable in identifying children at high risk of death and should therefore be routinely used in the community and health care settings. Better nutrition programming for both mothers and children, the promotion of exclusive breastfeeding, better caregiver education, and better nutrition screening in early childhood are key for lowering the burden of childhood malnutrition and for meeting national and global nutrition goals, such as the Sustainable Development Goals.

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