NUTRITION AS A HEALTH VITAL SIGN

Concept Note

MOMENTUM Country and Global Leadership

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MOMENTUM A Global Partnership for Health and Resilience

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MOMENTUM works alongside governments, local and international private and civil society organizations, and other stakeholders to accelerate improvements in maternal, newborn, and child health (MNCH) services. Building on existing evidence and experience implementing global health programs and interventions, we help foster new ideas, partnerships, and approaches and strengthen the resiliency of health systems.

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ABBREVIATIONS

ANC	Antenatal care
BMI	Body mass index
EAL	Evidence Analysis Library
FANTA	Food and Nutrition Technical Assistance
HCP	Health care provider
IMCI	Integrated Management of Childhood Illness
LBW	Low birthweight
LMICs	Low- and middle-income countries
MDD	Montreal Diet Dispensary
MN	Micronutrient
MNCH	Maternal, newborn, and child health
MSF	Médecins sans Frontières
MST	Malnutrition Screening Tool
MUAC	Middle-upper arm circumference
NACS	Nutrition Assessment, Counseling, and Support
NRS	Nutrition Risk Screening
PMST	Pediatric Malnutrition Screening Tool
PNST	Pediatric Nutrition Screening Tool
PYMS	Pediatric Yorkhill Malnutrition Score
OR	Odds ratio
STAMP	Screening Tool for the Assessment of Malnutrition in Pediatrics
STRONGkids	Screening Tool for Risk on Nutritional Status and Growth
SNAQ	Short Nutritional Assessment Questionnaire
USAID	United States Agency for International Development
WHO	World Health Organization

INTRODUCTION

Good nutrition promotes optimal growth and development in children, can reduce maternal and neonatal morbidity and mortality, and generally helps the body's immune system fight infection. It is particularly important for people with chronic disease, pregnant and lactating women, children under five years old, and others with special needs.

Nutrition screening uses quick and simple tools that require only minimal training and can take place in a health facility or community setting during growth monitoring and promotion programs at community events, household visits, or group meetings. Nutrition screening is a rapid process that identifies malnourished individuals or those at risk of a nutritional condition and refers them to a health facility, where a more detailed nutrition assessment is performed. The assessment should ideally include anthropometric (weight, height, or middle-upper arm circumference [MUAC]), biochemical (anemia screening), clinical (skin condition, hair, eyes, etc.), and dietary (24-hour recall, food frequency) methods[1] to identify possible nutrition problems and their causes. The collected information is used to develop an appropriate action plan for the prevention or treatment of malnutrition and other health conditions.

Vital signs are measurements of basic bodily functions, such as temperature, pulse, and blood pressure, which provide critical information about a person's current health status. The concept of anthropometry screening as a vital sign was proposed around 20 years ago by the Nutrition Screening Initiative as a means to identify, prevent, and manage nutritional risks that could cause further disability, mainly in elderly hospital patients.[2] The importance of nutrition in patient health and care began to feature in the field of oncology, for example, where screening patients for malnutrition was proposed as a "7th vital sign."

Although nutrition assessment approaches and tools have been developed in various forms across the continuum of care, with some reviewed for validity and reliability, they remain underutilized in low- and middle-income countries (LMICs), with gaps in both treatment and follow-up. Health facility workers, particularly in LMICs, have multiple duties, are often overworked, and face staff shortages, so assessments that take a lot of time or are complicated to implement are not contextually appropriate.[3,4,5] To be promoted as a health vital sign, standalone nutrition screening approaches and tools with identified cutoff points need to be verified as predictive for risk of morbidity and/or mortality.

The United States Agency for International Development (USAID) seeks to strengthen nutrition–health integration and engagement through use of the "Nutrition as a Health Vital Sign" concept. This approach involves further assessing the effectiveness of nutrition screening and indices as a vital sign across the maternal, newborn, and child health (MNCH) continuum of care to identify risk factors for morbidity and mortality, and respond with preventive and curative actions. MOMENTUM Country and Global Leadership conducted a desk review of various nutrition screening tools and nutrition assessment approaches for adults, pregnant women, adolescents, and children to document evidence of their predictive value to nutrition outcomes and risks for morbidity and mortality, as well as the effectiveness of using available tools as a health vital sign across the MNCH continuum of care. MOMENTUM Country and Global Leadership organized an external consultative workshop to solicit feedback and input from experts and partners on a draft of this concept note, which was prepared based on the initial desk review and on the use and applicability of nutrition assessment and screening tools as a vital sign in MNCH programs, especially in LMICs. This concept note presents the initial desk review of available literature, key takeaways from the expert and partner consultation, potential gaps for research, and next steps to move forward with the use of nutrition screening tools as a health vital sign in LMICs.

DESK REVIEW

ADULT NUTRITION SCREENING TOOLS

Maintaining adequate nutrition promotes good health and reduces the risk of disease in adults, and is particularly important for older people, who are more vulnerable to infection and disease. The early identification of patients at risk of malnutrition who start timely and adequate nutritional support is linked to positive outcomes, such as reduced mortality and reductions in the rate of severe complications.[6,7,8] At least 33 different nutritional risk screening tools exist and have been assessed in the United States and Europe.[9] The tools and supporting research focus primarily on the nutritional status of elderly populations in hospitalized/clinical settings, with chronic illness, or in relation to surgical outcomes, and, more importantly, the ability to identify the risk of morbidity and mortality, except for MUAC and body mass index (BMI), which are more commonly used in LMICs.

In 2014, Tangvik et al.[10] sought to investigate the association between nutritional status, screening, and clinical outcomes by reviewing four initial pre-screening questions included in the Nutritional Risk Screening (NRS) 2002 screening tool.* The study found that positive responses to the following four questions were associated with increased risk of morbidity and mortality:

- Is BMI <20.5?
- Has the patient lost weight within the past three months?
- Has the patient reduced dietary intake in the past week?
- Is the patient severely ill?

Patients for whom the answers to all four questions were affirmative had 10 times increased risk of mortality the following year (odds ratio [OR] 13.0 [95% confidence interval (CI) 4.52e37.6]). Patients who had a reduced dietary intake during the past week (question three) had an OR of 1.72 (95% CI 1.03 e2.85) for one year mortality. The authors concluded that the four initial questions of the NRS 2002 identify nutritional risk and are strong predictors of hospitalization, morbidity, and, most importantly, mortality among hospitalized patients. Thus, these short and simple nutrition screening questions are robust indicators of poor outcomes.

Hundreds of studies, including randomized controlled trials, have assessed and validated the NRS 2002, implemented as the complete screening tool, and found it to be reliable if administered by trained staff.[11] If one of the four pre-screening questions is answered positively, further screening follows, with static and dynamic parameters on the severity of the disease.

In 2013, Jensen et al. compared and discussed the four common screening tools described in Figure 1, noting the following key conditions for an ideal nutrition screening tool:[12]

- Acceptable validity
- Simple to administer
- Broad applicability across multiple clinical settings and patient conditions
- Uses commonly available information

* The Nutritional Risk Screening 2002 (NRS 2002) was developed by ESPEN as a system for screening hospitalized patients for the presence of undernutrition and the risk of developing undernutrition in the hospital.

FIGURE 1. SCREENING TOOL COMPARISON

Malnutrition Risk Screening Tools	Description	Parameters Used
Malnutrition Screening Tool (MST)[9]	MST is a simple, quick-to-administer, 2-question tool.	Unintentional weight loss[a] Appetite[a]
Nutritional Risk Screening–2002 (NRS-2002)[10]	Developed by ESPEN, this is a preferred tool to screen for malnutrition in European hospital settings.	Unintentional weight loss[a] BMI[a] Disease severity Age Impaired general condition
Malnutrition Universal Screening Tool (MUST)[11]	Developed for screening in the community, MUST is widely used in the United Kingdom and Europe.	Unintentional weight loss[a] BMI[a] Disease severity Food intake[a]
Short Nutritional Assessment Questionnaire (SNAQ)[12]	A simple, easy-to-administer, 3-question screening tool developed in the Netherlands for hospital screening.	Unintentional weight loss[a] Appetite[a] Use of oral supplement or tube feeding

BMI, body mass index; ESPEN, European Society for Clinical Nutrition and Metabolism.
[a]Academy of Nutrition and Dietetics/American Society for Parenteral and Enteral Nutrition diagnostic characteristic.

Source: Jensen et al. 2013

The Academy of Nutrition and Dietetics Evidence Analysis Library (EAL) conducted a comprehensive systematic review of the following six adult nutrition screening tools (with sufficient evidence):

- Malnutrition Screening Tool (MST)
- Malnutrition Universal Screening Tool (MUST)
- Mini Nutrition Assessment - Short Form (MNA-SF)
- Short Nutritional Assessment Questionnaire (SNAQ)
- Mini Nutrition Assessment - Short Form - Body Mass Index (MNA-SF-BMI)
- Nutrition Risk Screening (NRS 2002)

The review included 67 studies conducted from 2016 to 2018. It assessed the tools for validity[†] (sensitivity, specificity, positive predictive value, and negative predictive value), reliability, agreement, and generalizability, as well as costs across all care settings in the U.S. and European context, for acute and chronic medical conditions and ages.[13]

Table 1 identifies the components of each screening tool. The review concluded with an overall grade and evidence of strength.[‡] As Figure 2 shows, the MST performed well and received a better grade than the other five tools.[§]

[†] Validity is defined as the ability of the screening tool to identify those adults who are malnourished versus those who are not.

[‡] Grade I: strong evidence, Grade II: fair evidence, Grade III: limited, Grade IV: expert opinion only

[§] NSCRA_Validity_ALL_TOOLS.pdf (andeal.org)

TABLE 1. ELEMENTS AND NUTRITION RISK SCORING COMPONENTS OF SIX SCREENING TOOLS

TOOL	ELEMENT				MALNUTRITION RISK SCORING
	Recent Weight Loss	Appetite	BMI	Disease Severity	
Malnutrition Screening Tool (MST)	X	X			0–1 = No risk 2–7 = Risk
Malnutrition Universal Screening Tool (MUST)	X		X	X	0 = Low risk 1 = Medium risk 2 = High risk
Mini Nutrition Assessment-Short Form (MNA-SF)	X	X		X	12–14 = Normal 8–11 = Risk 0–7 = Malnutrition
Short Nutrition Assessment Questionnaire (SNAQ)	X	X			2 = Moderate 3 = Severe
Mini Nutrition Assessment-SF-BMI (MNA-SF-BMI)	X	X	X	X	12–14 = Normal 8–11 = Risk 0–7 = Malnutrition
Nutrition Risk Screening (NRS 2002)	X		X	X	≥3 points = Initiate a nutrition care plan

Source: https://www.andeal.org/topic.cfm?menu=5766&cat=5926

FIGURE 2. THE EAL ADULT SCREENING TEST VALIDITY MATRIX

	VALIDITY[1]					RELIABILITY[2]	AGREEMENT[2]	GENERAL-IZABILITY[3]	OVERALL GRADE, EVIDENCE STRENGTH[4]
TOOL	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	OVERALL VALIDITY[2]				
MST	Moderate	Moderate	Moderate	Moderate	**MODERATE**	**MODERATE**	**MODERATE**	**GOOD**	**I, GOOD/STRONG**
MUST	Moderate	Moderate	Moderate	High	**HIGH**	**MODERATE**	**MODERATE**	**FAIR**	**II, FAIR**
MNA-SF	Moderate	Moderate	Low	Moderate	**MODERATE**	**MODERATE**	**LOW**	**FAIR**	**II, FAIR**
SNAQ	Moderate	High	Low	High	**MODERATE**	**MODERATE**	-	**FAIR**	**II, FAIR**
MNA-SF-BMI	Moderate	Moderate	Moderate	High	**HIGH**	-	**MODERATE**	**LIMITED**	**II, FAIR**
NRS-2002	Moderate	High	Moderate	Moderate	**MODERATE**	-	**MODERATE**	**LIMITED**	**II, FAIR**

[1]Sensitivity, specificity, positive predictive value, negative predictive value cut offs: High: 90-100%, moderate: 80-≤89%, low: ≤79%; reliability and agreement Kappa cut-offs: High: 0.8-1; moderate: 0.6-≤7.9; low: ≤5.9.
[2]See Figure 1 for the algorithm to determine the overall validity.
[3]Generalizability was based on usefulness of each tool across the broadest array of adult age groups, locations, diseases, and treatments according to evidence.
[4]Elements considered in the overall grade include: quality of the evidence, consistency of results across studies, quantity of studies and number of subjects, clinical impact of outcomes, and generalizability to population of interest.

Source: https://www.karger.com/Article/Pdf/516528 (Table 2)

The EAL identifies the MST as a simple, quick, valid, and reliable tool developed for use in adult hospitalized patients. It is now used to identify patients at risk of malnutrition in many high-income countries. It consists of just two questions: decreased intake due to poor appetite and amount of recent unintentional weight loss. The sum of these parameters results in a score between zero and five. Patients are considered to be at risk of malnutrition if they receive a score of two or more.[**,14]

In LMICs, BMI and MUAC are more commonly used to assess nutritional status among adults. A 2017 review from the Food and Nutrition Technical Assistance (FANTA) identified that while low BMI is commonly used as a tool to detect undernutrition and has been shown to be associated with increased morbidity and mortality, it is difficult to collect accurate height and weight measurements.[15] MUAC is correlated with BMI and is simpler to administer but as yet has no globally recognized cutoff points to assess nutritional status. The FANTA study assessed potential MUAC cutoff points to identify undernutrition and found that MUAC cutoffs between ≤23.0 and ≤25.5 centimeters (cm) had acceptable levels of sensitivity and specificity for screening for undernutrition. The study therefore proposes using MUAC ≤24.0 cm as a cutoff, as it was optimized for both sensitivity and specificity across various subpopulations when assessed against low BMI. This recommendation, the authors note, needs to be validated through studies but if viable, MUAC could potentially reduce the time needed and technical skill necessary for nutritional screening of individuals in need of further nutritional assessment. More discussion on how to simplify or improve BMI for use as a vital sign is warranted given its proven association with morbidity and mortality, while further study is needed on MUAC cutoff points and effectiveness as a screening tool.

NUTRITION ASSESSMENT AND SCREENING TOOLS FOR PREGNANT WOMEN AND NEWBORNS

Pregnant women require additional nutrients and calories to support the growth of the fetus. Undernutrition and deficiencies in micronutrients (MNs) can increase the risk of morbidity and mortality for both the mother and the newborn, as well as increase the risk of complications during pregnancy and delivery.

Nutritional assessment during pre-pregnancy and early pregnancy can detect and identify the following risks:

- Malnutrition (undernutrition or overweight, anemia, low calcium)
- Maternal health (pre-eclampsia, gestational diabetes)
- Newborn health (morbidity, delivery outcomes, low birthweight[††] [LBW]/intrauterine growth restriction, small for gestational age, and mortality)

Much of the current literature regarding maternal nutrition screening and assessment is linked to newborn outcomes, such as LBW, anemia, MN status, and metabolic syndrome. It is recognized that undernutrition during pregnancy, with poor diets lacking in key nutrients—such as iodine, iron, folate, calcium, and zinc—can cause anemia, pre-eclampsia, hemorrhage, pre-term delivery, and death in mothers, and can also lead to stillbirth, LBW, wasting, and developmental delays for children.[‡‡,16] Nutrition screening tools assessed as identifiers of risk for pregnant women and newborns include BMI, MUAC, and gestational weight gain.

Multiple studies have assessed maternal anthropometry and the association between fetal growth and newborn birthweight, looking at specific BMI cutoffs, pre-pregnancy weight limits, and MUAC cutoff points.

[**] https://www.andeal.org/topic.cfm?menu=5382&cat=5925
[††] https://data.unicef.org/topic/nutrition/low-birthweight/
[‡‡] https://www.unicef.org/nutrition/maternal

In a 2009 study from Sri Lanka, Jananthan et al. looked at the usefulness of maternal anthropometry (weight/height/BMI) parameters as predictors of LBW.[17] Specifically, they examined the relationship between the birthweight of a full-term baby with certain maternal anthropometric measurements and determined the sensitivity, specificity, and risk ratio of these measures in predicting LBW. They concluded that the best predictor of infant birthweight (80 percent sensitivity) was a maternal BMI of 23.7 kilograms per square meter (kg/m^2) at or before 13 weeks' gestation. A similar study by Nahar et al. in Bangladesh found that the best predictor of LBW was maternal weight at registration, with a 0.26 kg birthweight increase per 1 kg increase in maternal weight at registration.[18] Additionally, a maternal weight ≤43 kg during gestational months 3–5 provided the highest sensitivity (80 percent) for predicting LBW.

Jeric et al. assessed the effect of low pre-pregnancy BMI on fetal growth, and found that the mean birthweight and birth length of neonates born to underweight mothers (<18.5 kg/m^2) were 167 grams and 0.8 cm less than those born to mothers of normal nutrition status ($p < 0.001$), with the prevalence of small for gestational age births among underweight mothers two times that of normal weight mothers.[19] The study concluded that although many environmental factors influence fetal growth and development, low maternal pre-pregnancy BMI is both a highly relevant assessment and simple to identify. As such, regulation of nutritional status to at least 18.5 kg/m^2 should be considered one of the most useful markers for women planning pregnancy. A meta-review of 26 studies in Africa also concluded that maternal BMI and greater gestational weight gain were positively associated with normal birthweight, while maternal anemia was associated with LBW.[20] In addition, the review found that maternal overweight and obesity were associated with an increased risk of macrosomia and intrauterine growth restriction.

A study by Riaz et al. (2012 to 2014) in Pakistan looked at the impact of maternal body weight on maternal nutrition and MN status in early pregnancy and the potential impact on metabolic status in newborns.[21] The study found a high prevalence of MN deficiencies in pregnant women during early pregnancy and among neonates was irrespective of birthweight or mothers' BMI.

MUAC has become a standard screening tool and indicator for undernutrition in children, as it is simple to implement and interpret in multiple settings with a globally accepted cutoff. MUAC has been increasingly used to assess the nutritional status of adults, especially pregnant women and people living with HIV for nutrition services, although no clear cutoffs have been recognized. A meta-review carried out in 2013 looked at 47 studies assessing the use of MUAC as a predictor of nutrition and health outcomes in pregnancy.[22] The review confirmed significant associations between low MUAC and adverse health outcomes (e.g., among pregnant women for infant LBW), but the authors also concluded that there was insufficient evidence to recommend an optimum MUAC cutoff point for any particular health outcome. A similar review was carried out in 2016, looking specifically at identifying a MUAC cutoff point to assess malnutrition in pregnant women. The review concluded that a global standard cutoff for all settings should be replaced by the results of country-led, context-specific analyses.[23]

A meta-review carried out by Médecins Sans Frontières (MSF) Switzerland looked at determining values of anthropometric indicators associated with adverse birth outcomes for pregnant women in the humanitarian context.[24] The search included studies from 1995 through 2012, and looked at MUAC, maternal BMI, maternal weight for gestational age, and maternal height, and compared the results to those of the World Health Organization (WHO) 1995 collaborative study.[§§] The review confirmed that MUAC cutoff points of <21 to <23 cm identified significant risk of LBW babies, but suggested using the more conservative cutoff of 23 cm for program entry to include most women at risk of delivering a LBW baby. Since no data was available to

[§§] https://apps.who.int/iris/handle/10665/52910

assess levels of malnutrition in pregnant women, the review also established parameters to differentiate between moderate and severe malnutrition. Additionally, the review confirms linkage between low gestational weight gain and LBW. While maternal height lacks a clear cutoff value for use in LMICs, there was an association between short maternal stature and increased risk of obstructed labor and infant underweight, with a cutoff of 146–157 cm that could be used to identify risk of LBW and obstetric complications. MSF noted that while BMI can vary substantially during pregnancy, it is a predictor of risk of LBW; however, no narrow range of cutoff points exists for use within a specific trimester to predict LBW in the Asian or African context. Maternal weight for gestational age was also noted to be a problematic measure in humanitarian contexts due to the difficulties in identifying gestational age, therefore a cutoff was not recommended. There was, however, an indication that pregnant women <45 kg should be further investigated for screening for LBW in the Asian context.

In 2018, the EAL carried out a systematic search and review of screening tools specifically related to assessing the impact of maternal nutrition on maternal health outcomes, instead of on pregnancy/infant outcomes. Of 38 available studies,[***] only one specifically addresses malnutrition in pregnancy. In 2008, Duquette et al. compared the Higgins method (as a reference) with the original Montreal Diet Dispensary (MDD) screening tool (26 variables) and a simplified MDD screening tool (16 variables) to screen 300 low-income pregnant women.[25] The study, confirmed by the EAL review, concluded that the simplified MDD screening offered an acceptable measure of nutritional risk in pregnancy.

A study carried out in 2018 by Scholing et al. investigated the association between pre-pregnancy BMI and MN status during pregnancy.[26] Maternal blood samples were collected, with modeling carried out to assess possible associations between pre-pregnancy underweight, normal weight, overweight, and obesity and MN levels, as well as the odds for deficiencies. The study found that women who were underweight (BMI < 18.5 kg/m^2) had lower MN levels and were more likely to have deficiencies than women with normal weight, yet the differences were not significant. They also found that women who were overweight or obese pre-pregnancy had significantly lower serum folate, iron, and vitamin B12 levels during early pregnancy than women of normal weight, and the odds for deficiency among these women were two or three times higher than for women of normal weight.

NUTRITION ASSESSMENT AND SCREENING TOOLS FOR CHILDREN

Optimal nutrition status is important for child growth and development. Nutrition screening is therefore important to identify nutritional problems early and begin the child on therapeutic treatment if needed. Health facility staff thus need to have access to valid and reliable screening tools, which require minimal training and are simple and time-efficient to use.

Similar to its review of screening tools for adults, the EAL carried out a systematic review of nutrition screening tools for children in 2017–2018, which assessed 14 tools for validity and reliability, including the Integrated Management of Childhood Illness (IMCI) algorithm and MUAC.[27] Studies of the various tests were applicable in different settings, including inpatient/hospital, outpatient/clinical, and the community, primarily in high-income countries, except for IMCI. The table excerpt (Figure 3) shows the EAL results, with validity, reliability, agreement, and overall grade/strength assessed.

FIGURE 3. EXCERPT FROM THE EAL CHILD SCREENING TOOL VALIDITY MATRIX

[***] https://www.andeal.org/topic.cfm?menu=5529

The evidence for validity, reliability and agreement of pediatric nutrition screening tools for identifying risk of malnutrition

	VALIDITY[1]					RELIABILITY[2]	AGREEMENT[2]	GRADE, EVIDENCE STRENGTH[3]
TOOL[4]	Sensitivity	Specificity	PPV	NPV	OVERALL VALIDITY[5]			
E-KINDEX						**LOW[6]**	**NR**	**III, LIMITED**
Obesity/overweight vs. normal weight	Low	Low	Low	Moderate	**LOW**	-	-	-
Obesity vs. normal weight/overweight	Low	Low	Low	High	**LOW**	-	-	-
IMCI Algorithm						**NR**	**NR**	**III, LIMITED**
Severe wasting	Low	High	Low	High	**LOW**	-	-	-
Very low weight-for-age	Low	High	Moderate	High	**MODERATE**	-	-	-
Bipedal edema	Low	High	Low	High	**LOW**	-	-	-
Severe wasting and/or bipedal edema	Low	High	Low	High	**LOW**	-	-	-
Stunted growth	Low	Low	Low	High	**LOW**	-	-	-
NRST for CF	Moderate	Low	Moderate	Moderate	**MODERATE**	**HIGH**	**NR**	**II, FAIR**
NutriSTEP						**HIGH[7]**	**HIGH**	**III, LIMITED**
Moderate risk cut point	Low	Low	Low	Low	**LOW**	-	-	-
High risk cut point	Moderate	Low	Low	Low	**LOW**	-	-	-
NutriSTEP (Toddler)						**HIGH[7]**	**NR**	**III, LIMITED**
Moderate risk cut point	Moderate	Low	Low	Moderate	**MODERATE**	-	-	-
High risk cut point	High	Low	Low	High	**MODERATE**	-	-	-
PMST	High	Low	Low	High	**MODERATE**	**NR**	**LOW**	**II, FAIR**
PNRS	High	Low	Low	Moderate	**MODERATE**	**NR**	**LOW**	**III, LIMITED**
PNST						**NR**	**NR**	**II, FAIR**
Weight-for-age z-score (≤-2)	Moderate	Low	Low	High	**MODERATE**	-	-	-
Weight-for-age z-score (≤-3)	High	Low	Low	High	**MODERATE**	-	-	-
Height-for-age z-score (≤-2)	Low	Low	Low	High	**LOW**	-	-	-
Height-for-age z-score (≤-3)	Low	Low	Low	High	**LOW**	-	-	-
Body mass index (BMI) z-score (≤-2)	Moderate	Low	Low	High	**MODERATE**	-	-	-
BMI z-score (≤-3)	High	Low	Low	High	**MODERATE**	-	-	-
BMI ≥85th percentile	Low	Low	Low	Low	**LOW**	-	-	-
Dietitian assessment	Low	Moderate	Low	Moderate	**LOW**	-	-	-
PYMS	Moderate	Low	Low	High	**MODERATE**	**MODERATE**	**LOW**	**II, FAIR**
SCAN	High	Low	Low	High	**MODERATE**	**NR**	**NR**	**III, LIMITED**

	VALIDITY[1]					RELIABILITY[2]	AGREEMENT[2]	GRADE, EVIDENCE STRENGTH[3]
TOOL[4]	Sensitivity	Specificity	PPV	NPV	OVERALL VALIDITY[5]			
STAMP	Moderate	Low	Low	High	**MODERATE**	**HIGH**	**LOW**	**I, GOOD/STRONG**
STAMP (Modified)	Low	Moderate	Low	Moderate	**LOW**	**NR**	**LOW**	**II, FAIR**
STRONGkids	Moderate	Low	Low	High	**MODERATE**	**MODERATE**	**LOW**	**II, FAIR**

[1]Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) cut offs: High: 90 to 100%, moderate: 80 to ≤89%, low: ≤79%.
[2]Reliability (inter-rater) and agreement kappa cut-offs: High: 0.8 to 1; moderate: 0.6 to ≤7.9; low: ≤5.9. Inter-rater reliability is reported, unless otherwise specified. NR=not reported.
[3]Elements considered in the overall conclusion statement grade include: Quality of the evidence, consistency of results across studies, quantity of studies and number of subjects, clinical impact of outcomes, and generalizability to population of interest.
[4]E-KINDEX=Electronic Kids Dietary Index; IMCI Algorithm=Integrated Management of Childhood Illness Nutrition Algorithm; NR=not reported; NRST for CF=Nutrition Risk Screening Tool for Cystic Fibrosis; NutriSTEP=Nutrition Screening Tool for Every Preschooler; NutriSTEP (Toddler)=Toddler Nutrition Screening Tool for Every Preschooler; PeDiSMART=Pediatric Digital Scaled Malnutrition Risk screening Tool; PMST=Paediatric Malnutrition Screening Tool; PNRS=Pediatric Nutrition Risk Score; PNST=Pediatric Nutrition Screening Tool; PYMS=Paediatric Yorkhill Malnutrition Score; SCAN=Nutrition Screening tool for Childhood Cancer; STAMP=Screening Tool for the Assessment of Malnutrition in Pediatrics; STAMP (Modified)=Modified Screening Tool for the Assessment of Malnutrition in Pediatrics; STRONGkids=Screening Tool for Risk on Nutritional status and Growth. NOTE: PeDiSMART was not included in the table, because no evidence meeting inclusion criteria was found to determine validity and reliability of the tool.
[5]Based on the algorithm to determine the overall validity found in the *NSP: Validity and Reliability Criteria* section (www.andeal.org/nsp).
[6]Reliability (internal reliability) Cronbach's alpha cut offs: High: α≥0.8, moderate: 0.8>α≥0.7, low: 0.6>α.
[7]Reliability (test-retest reliability) Intraclass correlation coefficient (ICC) cut offs: High: 0.75 to 1.0, moderate: 0.5 to 0.75, low: <0.5.

The EAL assessed MUAC, noting its use in high-income countries, and found that it demonstrated low validity in identifying risk of malnutrition related to undernutrition in children. However, the two studies that met the inclusion criteria were carried out in Australia, and not in an LMIC context. EAL concluded that the IMCI algorithm demonstrated low validity in identifying risk of malnutrition based on visual observations of either severe wasting, bipedal edema, severe wasting or bipedal edema, or stunted growth, and moderate validity in identifying risk of malnutrition based on very low weight for age, in children admitted to the hospital. This assessment was based on one study from the Gambia that met the inclusion criteria.

The Screening Tool for the Assessment of Malnutrition in Pediatrics (STAMP) performed best in the assessment, with moderate validity, high reliability, and strong evidence.[†††] STAMP was developed in the United Kingdom for hospitalized children aged 2–17 and has five components:

[†††] https://www.stampscreeningtool.org/

- Clinical diagnosis
- Estimated nutritional intake
- Weight and height percentiles
- Risk determination
- Care plan

Each of the first three components has a score of 1–3, with the total score indicative of the risk of undernutrition. A score of 2 or 3 indicates medium risk and a score ≥4 indicates high risk.[28,29] STAMP was modified for use in outpatient clinics, and presumes that any deviation is a nutrition risk, so a score of 1 to 3 is classified as medium risk.

The Pediatric Malnutrition Screening Tool (PMST) is a modified version of STAMP that includes children under two years of age. The Pediatric Nutrition Screening Tool (PNST) was designed to be simple to use, with two affirmative responses to four yes/no questions (weight loss, poor weight gain, decreased intake, visibly under/overweight) marking a predictor of nutrition risk.

IMCI is an integrated approach to child health that focuses on the well-being of the whole child and is widely implemented in LMICs. WHO developed IMCI for health workers in primary-level facilities in LMICs to identify and manage sick children. Nutrition assessment is integral to the evaluation of sick infants and children and also central to the care of well children and promoting their health and development. The IMCI algorithm reflects WHO recommendations on anthropometric assessment and infant and child feeding. Successful implementation, however, depends on the training of health facility staff and their motivation to complete the assessment. One recent study from Burundi conducted direct observations of outpatient consultations for children aged 6–59 months in 90 health centers.[30] The study evaluated the extent to which health workers practice the nutrition component of the IMCI guidelines. The findings showed poor compliance by health workers to IMCI: out of 514 consultations, none administered all seven nutrition-related questions, and only 3 percent included all of the nutrition screenings (weight, height/length, MUAC, edema, growth curve, and weight/height z-score). Of 99 health workers who received children under two, only 39 percent weighed or discussed the weight taken at the prior consultation and only 26 percent measured the height/length. Anemia and vitamin A deficiency, although a part of the IMCI protocol, were not included in the statistic.

A recent scoping review looked at 24 studies and identified four key challenges facing health care workers who implement IMCI.[31] Three of the challenges directly relate to the implementation of screening protocols: lack of training, mentoring and supervision, and the length of time required for effective and meaningful IMCI consultations, which conflicts with competing demands and insufficient financial resources to fund program activities. A study from the Philippines identified similar challenges: insufficient financial resources to fund program activities, and inadequate training, mentoring, and supervision for providers.[32]

MUAC is a common single screening tool for malnourished children in LMICs, particularly in humanitarian settings and for screening into nutrition programs. Traditionally, it has served as a proxy measure for undernutrition, particularly severe acute malnutrition for children under age five.[33] It has also been shown to be a predictor of mortality risk.[34,35,36] MUAC and anthropometry (weight/height/BMI) have been shown to have variability (inter-/intra-observer) in measurements, particularly when comparing measurements of the same child by different observers.[37,38] Potential errors include not using the equipment correctly and inaccurate reading/recording of measurements. Study findings do indicate, however, that with sufficient training, errors can be minimized, and measurement by untrained community health workers is feasible,

particularly in rural areas, where there is often a shortage of skilled personnel available for anthropometric monitoring.

A recent study carried out among Sri Lankan schoolchildren assessed the ability of MUAC to predict malnutrition (over and undernutrition) in schoolchildren.[39] The results found MUAC to be a highly accurate predictor of overweight/obesity and a moderately accurate predictor of thinness. The study also identified different optimal sex-age specific and birthweight cutoff values. The study concluded that MUAC is a good predictor of malnutrition (under- and over-nutrition in Sri Lankan schoolchildren) and that MUAC cutoff values for malnutrition differ according to age group and birthweight.

The USAID-funded Food by Prescription model was developed in 2006 for people living with HIV. It includes nutrition assessment, counseling, and prescription of supplementary food. The model became known as Nutrition Assessment, Counseling, and Support (NACS)[‡‡‡] as greater emphasis was placed on counseling. NACS includes four components:

- Nutrition assessment, where information, such as medical history, dietary patterns, anthropometry, and clinical and biochemical signs are collected on the individual
- Classification
- Nutrition intervention
- Monitoring and evaluation

NACS provides guidance for nutrition screening, including the advice that prior to a full nutrition assessment, a quick and simple identification be carried out for people who are malnourished or at risk of being malnourished, who can then be followed up with for a more detailed assessment.

NACS modules provide step-by-step guidance for nutrition assessment for health care providers (HCPs), such as how to prioritize clients for assessment and how often clients should be assessed. It also clearly explains each type of assessment: weight, length for height, weight for height, MUAC, BMI, biochemical, and clinical and dietary assessments.

[‡‡‡] NACS stands for nutrition assessment, counseling, and support. It is a client-centered programmatic approach for integrating a set of priority nutrition interventions into health care services and strengthening health systems. NACS covers prevention, detection, and treatment of malnutrition and maintenance of improved nutritional status to prevent relapse. https://www.fantaproject.org/sites/default/files/resources//NACS-Users-Guide-Module1-Apr2016_0.pdf

DISCUSSION

To strengthen nutrition–health integration and engagement through use of the Nutrition as a Health Vital Sign concept, validated and reliable approaches for assessing and identifying the risk of malnutrition and subsequent morbidity and mortality must be identified; or, if these approaches are not currently available, invested in as an urgent research need. These approaches must be simple, user-friendly, and feasible for use according to the providers' capacity.

This concept note reviewed the evidence for various nutrition screening tools and nutrition assessment approaches available for adults, pregnant women, newborns (since the health outcome of the newborn is inextricably linked to the health and nutritional status of the mother, and various tools are predictive for nutrition outcomes of one or both), and children.

Multiple studies have assessed and compared different nutrition screening tools for adults, validating them for predictive value of morbidity and mortality. It is useful to consider the reviews of these tools, as they exemplify screening tools that use various components of nutrition assessment, such as anthropometry, dietary assessment, and clinical signs, and have been well-studied. The NRS 2002 tool and its modified version, which uses only the first four pre-screening questions (BMI, weight loss, dietary intake, and clinical assessment), have been thoroughly assessed, are quick to administer, and have evidence of predictive value for morbidity and mortality. The MST (which consists of two questions: decreased intake due to poor appetite and amount of recent unintentional weight loss) is also a simple, quick, valid, and reliable tool, which is now used to identify patients at risk of malnutrition in many high-income countries.

Nutrition screening tools and assessment for pregnant women are more complicated. Various tools or methodologies have been developed to assess the health or nutritional status (anthropometry, biochemical), and then provide an assessment that is either predictive of maternal nutrition status/outcomes, or newborn/pregnancy outcomes, or both. Maternal BMI has been shown to be a predictor of LBW, with babies born to mothers with pre-pregnancy BMI of less than 18.5 kg/m^2 weighing 16 grams less than babies born to mothers with normal pre-pregnancy BMI. There was also some evidence of BMI being predictive of poor maternal MN status.

Studies have also shown significant associations between low MUAC and various adverse health outcomes, including LBW, but there is no evidence for an optimum MUAC cutoff point related to any one health outcome.

The modified MDD screening tool is the only nutrition screening tool that has been identified as valid and reliable for predicting maternal nutrition outcomes and maternal nutritional risk during pregnancy. The MDD is also the only tool that uses multiple assessment questions, compared with single indicator assessments such as BMI or MUAC.

Nutrition screening tools for children include STAMP, awarded a grade I from the EAL for validity and reliability, which has been modified for use in an outpatient setting as well as hospital/inpatient. STAMP includes BMI, clinical diagnosis, and dietary intake, and is easy to administer.

IMCI is also a well-known and widely implemented algorithm for nutrition assessment, particularly in LMICs. IMCI includes anthropometry (weight/height or MUAC) and counseling, if needed, which requires thorough training.

Studies of MUAC have shown it to have some predictive value for malnutrition and mortality, although as a single indicator, it has limitations.

Most widely studied nutrition screening tools are hospital or clinic (outpatient) based. The tools evaluated by EAL include anthropometry, dietary assessment, and clinical assessment. Screening tools for pregnant women predominately focus on BMI or maternal weight, with some biochemical assessment, and are specific to health/nutrition outcomes, such as LBW. There is a knowledge gap for pregnancy nutrition screening tools predictive of maternal risk of malnutrition. There is also a gap regarding cutoff points for BMI and MUAC in determining levels for poor outcomes. The more highly validated and reliable tests, either for adults or children, combine multiple elements of anthropometry, dietary assessment, and clinical assessment.

Existing and potential screening tools need to be tested in LMIC contexts at health clinic and health post levels to ensure that the tools are simple to learn and administer, and quick to use. To test appropriateness, some tools and cutoff points need to be assessed in the country context, as shown by the MUAC for school-aged children study. Little evidence exists for adolescents, except for MUAC, so further study and consideration of specific tools for this age group are needed. Dietary assessment was included in most of the validated screening tools, but it consisted of one or two simple questions, not complex indicators such as women's dietary diversity. The application of this simpler approach should be considered in the LMIC context for ease of delivery.

While multiple nutrition screening tools have been identified and assessed for validity, anecdotal information indicates that they are not being used in antenatal care, postnatal care, or during child health visits. As noted earlier, health facility workers, particularly in LMICs, have multiple duties and are often overworked and face staff shortages; thus, for nutrition to be considered as a vital sign, it is critical that appropriate screening tools or indicators are easy for health staff to train on and simple and quick to implement. It should, however, be noted that even simple tools have potential for error, which needs to be addressed.

Table 2 summarizes the nutrition screening measures and tools included in this review.

TABLE 2. SCREENING TOOLS FOR NUTRITION AS A HEALTH VITAL SIGN

Target group	Screening tool	Assessed in LMIC context
Adult	Malnutrition Screening Tool (MST)	
	Nutrition Risk Screening 2002 (NRS 2002)	
	Malnutrition Universal Screening Tool (MUST)	
	Mini Nutrition Assessment - Short Form (MNA-SF)	
	Mini Nutrition Assessment SF - BMI (MNA-SF-BMI)	
	Short Nutrition Assessment Questionnaire (SNAQ)	
	Body mass index (BMI)	X
	Middle-upper arm circumference (MUAC)	X
Pregnant Women/ Newborns	Maternal BMI	X
	Maternal MUAC	X
	Maternal body weight	X
	Maternal weight for gestational age	X
	Maternal height	X
	Pre-pregnancy BMI	X
	Montreal Diet Dispensary (MDD) tool	
Adolescent	MUAC (school-aged children)	X

Target group	Screening tool	Assessed in LMIC context
Children	Screening Tool for the Assessment of Malnutrition in Pediatrics (STAMP)	
	Pediatric Malnutrition Screening Tool (PMST)	
	Pediatric Nutrition Screening Tool (PNST)	
	Pediatric Yorkhill Malnutrition Score (PYMS)	
	Screening Tool for Risk on Nutritional Status and Growth (STRONGkids)	
	Integrated Management of Childhood Illness (IMCI)	X
	MUAC	X
	Nutrition Assessment, Counseling, and Support (NACS)	X

EXPERT CONSULTATION

This "Nutrition as a Health Vital Sign" concept note, which presents evidence from available literature on the potential use of nutrition measures as part of a health vital sign, was shared with a group of technicians to serve as guidance for an expert consultation and to capture feedback and assist with the way forward. Invitees to the consultation included representatives from USAID, WHO, UNICEF, academic institutions, and international nongovernmental organization programmers. The technical consultation was held virtually on October 25, 2021, with 25 attendees (see the meeting report for a list of participants[§§§]).

The expert consultation objectives were to:

- Review and discuss experiences, evidence, and gaps in using nutrition assessments as a vital sign, as documented in the draft concept note.
- Solicit expert opinions on the use and applicability of various nutrition assessments and screening measures for use in LMICs.
- Discuss potential research and learning questions.

The consultation included three presentations: "Opening Remarks," "Nutrition as a Health Vital Sign," and "Considerations for Nutrition Assessment in Clinical and Public Health Settings," followed by breakout sessions and a plenary discussion. Key points from the discussion and breakout sessions are presented here, as well as some new points for consideration that were not covered in the literature review but were discussed in the consultation.

TOPIC 1: HOW CAN WE INCREASE UPTAKE OF EXISTING SCREENING TOOLS AS HEALTH VITAL SIGNS IN ALL CONTEXTS?

LOCAL CONTEXT AND HCP PERCEPTIONS

An important discussion topic was ensuring consideration of the local context and the perceptions/barriers of HCPs. Differing types of clinics or health facilities across varying contexts will set different priorities for nutrition. For instance, a clinic or unit might be more focused on stabilizing a child in an acute phase or focusing on a particular problem, resulting in a lack of prioritization for nutrition screenings. Additionally, health workers in this context may lack the training or expertise in nutrition to manage the situation. Another

[§§§] https://usaidmomentum.org/resource/nutrition-as-a-health-vital-sign/?utm_source%E2%80%A6

aspect is ensuring the involvement of LMIC HCPs in the decision/design of a nutrition vital sign tool to avoid any bias resulting from the global community defining both the problem and solution. This includes identifying and understanding LMIC HCP perceptions of using nutrition measures as a health vital sign and what they understand nutrition screening will do for them and their clients in terms of decision-making. If they don't understand or see the value, then regardless of which nutrition screening tool is identified as a vital sign, there will continue to be issues with uptake and utilization. This is also the case with anthropometry, which is challenging to do correctly with children, and thus easier to ignore. The expert consultation therefore identified a need to focus on communication with service providers, address barriers to uptake, and help them to understand nutrition more broadly, including the consequences of undernutrition and the value of the tools as vital signs and how they relate to their work.

WORKLOAD, TIME, AND CAPACITY CONSIDERATION

The workload and time consideration of HCPs implementing nutrition screening tools was also discussed at length during the consultation. In LMICs, HCPs are often overwhelmed with the number of patients they must see and do not have adequate time to go in-depth with assessments, addressing instead only the most critical or life-threatening condition. There is often not enough time to carry out nutritional assessments or do them accurately, and especially not to interpret them and develop a treatment plan. Additionally, nutrition training and capacity is often not adequate in LMICs, so HCPs may not feel confident about addressing a problem found in a nutritional screening. For antenatal care (ANC), midwives often do weight and MUAC measurements, but as they are already overworked, additional measurements, such as a two-stage screening or diagnostic analysis, may need to be done by someone else. This poses a challenge given that there is already a shortage of midwives in many LMICs. The lessons identified from the consultation are not to solely rely or focus on the "tool" as the solution, but to also understand provider capacity and barriers to uptake and take into consideration the time needed to screen and counsel on preventive measures and develop a treatment plan.

SCREENING TOOLS AND ANTHROPOMETRY

As previously noted, anthropometric measurements can be challenging, sometimes requiring two people to carry out in overstretched and overworked environments with many sick children or in busy ANC clinics. Existing nutrition screening tools or methods currently being implemented in LMICs need to be better understood and maximized to increase uptake, rather than adapting new tools more commonly used in high-income countries. MUAC is a simple tool but is not considered by HCPs to be as important as weight, possibly due to poor understanding of it. Nutrition screening tools used in LMICs have not been assessed for their reliability or validity in determining general morbidity or mortality as they have in high-income countries, indicating a need for further research. Screening tools also need to be assessed and compared against outcomes of a decision tree to determine the relevance of each tool and to assess the tools in the context of next steps. Lastly, due to the issues noted in LMIC contexts, such as workload, capacity, provider perceptions, etc., a single nutrition screening tool is preferable to multiple assessments, and a one-stage approach (anthropometric and dietary/feeding assessment at the same time) is more feasible than a two-stage approach (anthropometric assessment followed by dietary assessment) in LMICs. The format and delivery of this tool needs to be simple, efficient, and unintimidating in order to address uptake. The application of smart anthropometry, such as new cell phone technologies and electronic measurements, should also be considered to address poor quality measurements and time constraints.

ELECTRONIC MEASUREMENTS FOR ANTHROPOMETRY

Despite the tools available, there is poor data quality in high-income countries as well as LMICs, which training doesn't always improve. New and innovative tools are now being used as an alternative way to address problems. One exciting development in noninvasive screenings is the future use of smartphones to interpret hemoglobin levels through photos of nailbeds, which research shows performs similarly to other noninvasive screenings. There is also an ongoing study that uses tablet or smartphone 3D technology to measure child anthropometry, which would save time and simplify nutrition screenings. However, these have largely been tested in high-income countries. Electronic measurements for anthropometry and simplifying measurements using technology can address some of the challenges identified, such as time constraints, the need for additional staff to interpret data, etc. The question remains, however, whether these smartphone tools are as valid and accurate as traditional anthropometry and what the feasibility is of their application in LMICs to improve measurements and increase screening uptake.

TOPIC 2: WHAT DO WE DO NEXT TO GENERATE EVIDENCE?

First, HCPs need to be included in the discussion and assessment of nutrition screening tools for LMICs. Often an assessment is done that includes the providers' perspectives, but the questions asked are too specific. Providers need to be included in the discussion before there is a tool, and should be asked what the problems are and what they need, so that these inputs can be incorporated earlier into the process to better understand the context, how they set their priorities, and what their challenges are. The expert consultation discussed building this out into case studies to understand if/how nutrition is incorporated into vital sign assessment. More implementation research is needed to identify the most accessible and efficient way of mainstreaming assessments into the point of contact in a given context. There is also a need for more insight into the perceptions, receptivity, and acceptability of testing for health workers, in addition to an assessment of the usability and adaptability, time constraints, and ease of use for existing tools.

SUGGESTIONS FOR FURTHER KNOWLEDGE AND PROGRAM CONSIDERATION

- There is a clear need to better understand existing nutrition screening tools for children and pregnant women during ANC in LMIC settings. Some areas for clarification include why screening tools are not being used, capacity restraints for both technical and human resources, and provider perceptions regarding their utility and importance. Moving forward, it will be essential to ensure that screening and monitoring measures and nutritional screening tools and follow-up are easy to use, understood, and accepted by busy HCPs in LMICs. They also have to be linked to specific actions that health workers can take if a client's nutrition vital sign measurement is below or above a standard cutoff, such as identifying risk level, counseling, treatment, or referral.
- Nutrition is not currently thought of as a health vital sign, but it needs to be framed as such. Among HCPs, there is a need to create awareness of the concept of nutrition measurement as a vital sign through training and mentoring.
- More research is needed on the validity and reliability of nutritional screening tests for predicting morbidity and mortality in the LMIC context.
- With IMCI now being implemented in more than 100 countries, more evidence should be gathered on whether effective implementation of nutrition screening is taking place and the key bottlenecks in areas where it is not.

- Studying a combination of rapid screening tests, such as a combination of MUAC or BMI, anemia color scale, and simple dietary assessment, could be useful in predicting overall risk for maternal and pregnancy outcomes.
- There is a knowledge gap for reliable and validated pregnancy nutrition screening tools that are predictive of maternal risk for malnutrition, not pregnancy outcome. There is also a need to generate evidence to determine pregnancy MUAC cutoff points for indicating risk of particular health outcomes or stage of undernutrition.
- Further testing of innovative technology solutions, such as electronic measures for nutritional screenings like anthropometry and anemia in LMICs, is needed to assess their feasibility, acceptability, ease of understanding and use, and potential time savings in these settings.
- Little evidence exists for adolescents, except for MUAC, so further study and consideration of specific tools for this age group are recommended.

NEXT STEPS

The expert consultation and subsequent discussions determined that moving forward with the concept of Nutrition as a Health Vital Sign may be better facilitated by limiting its scope to the review of a few tools, and prioritizing IMCI for children and ANC for pregnant women in the LMIC context. It is also equally important to sensitize the broader global health community on the concept of Nutrition as a Health Vital sign. The first action will be to develop a commentary paper for publication in *Global Health: Science and Practice* and other relevant journals. The objective of this commentary is to introduce the Nutrition as a Health Vital Sign concept to global MNCH and nutrition communities as well as health professionals engaged directly in service delivery and health program design and implementation. The second action will be to develop a research protocol to better understand the barriers that impede HCPs' implementation of existing screening tools used for IMCI and ANC in one to two countries, as well as HCPs' perspectives on the use and value of nutrition screenings for the assessment of patients and as a health vital sign.

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