Expanded Pediatric Nutrition-Focused Physical Exam

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No disclosures.

Objectives

1. Explain three considerations when using body composition in pediatrics.

2. Develop familiarity with micronutrient NFPE in pediatrics.

3. Develop ways to reduce barriers while performing NFPE in pediatrics.

Table of Contents

Word Cloud for Pediatric Nutrition-Focused Physical Exam (PNFPE):

What is in a pediatric NFPE?

Introduction:

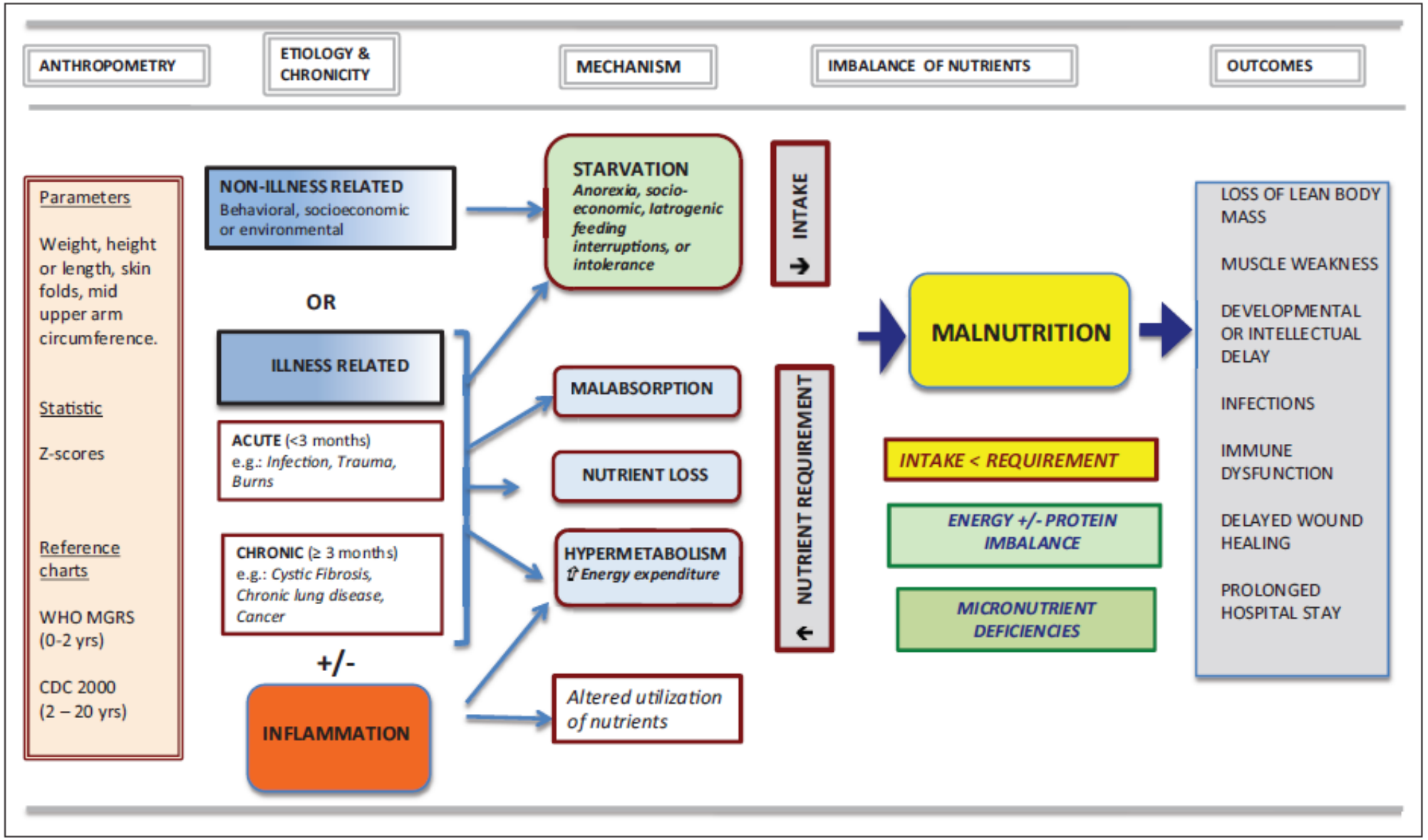


Figure 1. Defining malnutrition in hospitalized children: Key concepts. CDC, Centers for Disease Control and Prevention; MGRS, Multicenter Growth Reference Study; WHO, World Health Organization.

Mehta NM, Corkins MR, Lyman B, et al. Defining pediatric malnutrition: a paradigm shift toward etiology-related definitions. *JPEN J Parenter Enteral Nutr*. 2013;37(4):460-481. doi:10.1177/0148607113479972

Introduction:

Developmental Milestones?

Body Composition?

Micronutrients?

Sexual Development?

Nervous System?

Basic Pediatric NFPE

Appropriate growth chart.

- Fenton - Premature birth up to 50 weeks (correct age).
- WHO Birth – 2 years of age (correct age for prematurity 2-3 years).
- CDC – 2 – 18 years of age.
- *Specialty growth charts can be used as an additional form of assessment; use CDC BMI growth chart.

Body habitus (shape/type) – under/normal/overweight.

Assess symmetrically. Also take note if limbs are symmetrical or missing.

Pull from other exams to limit another in-depth exam on a child or unable to complete full exam.

Can be head-to-toe or focused.
Example: looking for iron deficiency anemia.

Goday PS, Walia C. Pediatric Nutrition for Dietitians. 1st ed. Taylor & Francis Group; 2022.
Green Corkins K, Teague EE. Pediatric Nutrition Assessment: Anthropometrics to Zinc. *Nutr Clin Pract*. 2017;32(1):40-51. doi:10.1177/0884533616679639

Measures and Ages

Weight (WT)

Birth to 2 years (adjusted age) – prefer infant/toddler scale; undress/dry diaper.

> 2 years old – if able to stand, standing scale; remove shoes and outerwear.

Length/Height (LT/HT)

Birth to 2 years (adjusted age) OR unable to stand – Measure laying down; using length board.

> 2 years old – If able to stand, stand with heels, buttocks, shoulder and head against stadiometer. Remove shoes, hats and any hair pieces.

Head circumference (HC)

Birth to 3 years (adjusted age). Remove any hair ornaments that could interfere with measure.

If concerned for chronic, severe malnutrition, Nellhaus created a HC for Birth to 19 years.

Weight/Length (WT/LT) Birth to 2 years old (adjusted age).

Body Mass Index (BMI) 2 years old – adult.

Mid Upper Arm Circumference (MUAC) Ages 3 months and up. Z-scores start at 6 months of age.

Other measures: Arm Span, Tibial Length, Knee Height, Ulna.

Goday PS, Walia C. Pediatric Nutrition for Dietitians. 1st ed. Taylor & Francis Group; 2022.
Nellhaus G. Head circumference from birth to eighteen years. Practical composite international and interracial graphs. *Pediatrics*. 1968;41(1):106-114.

Measures and Ages

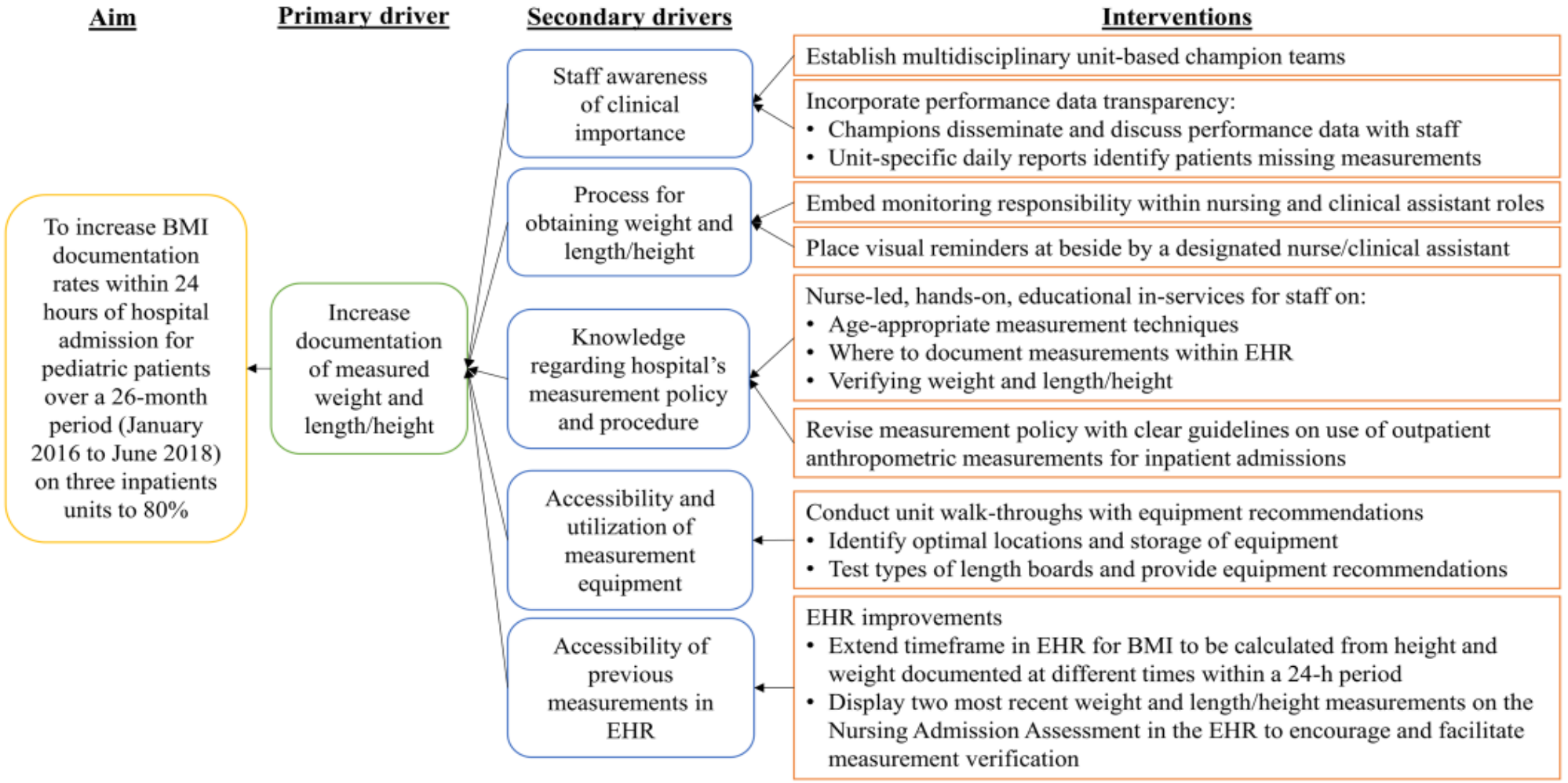
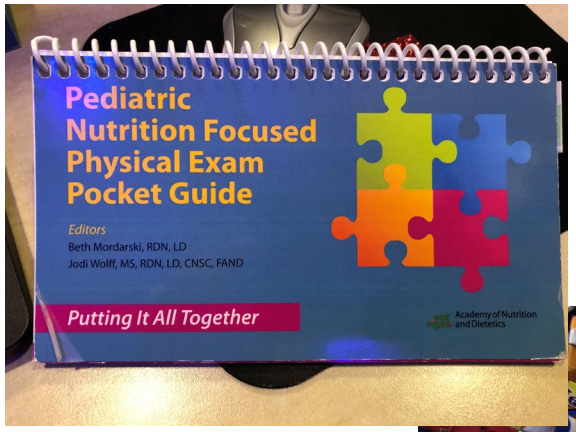


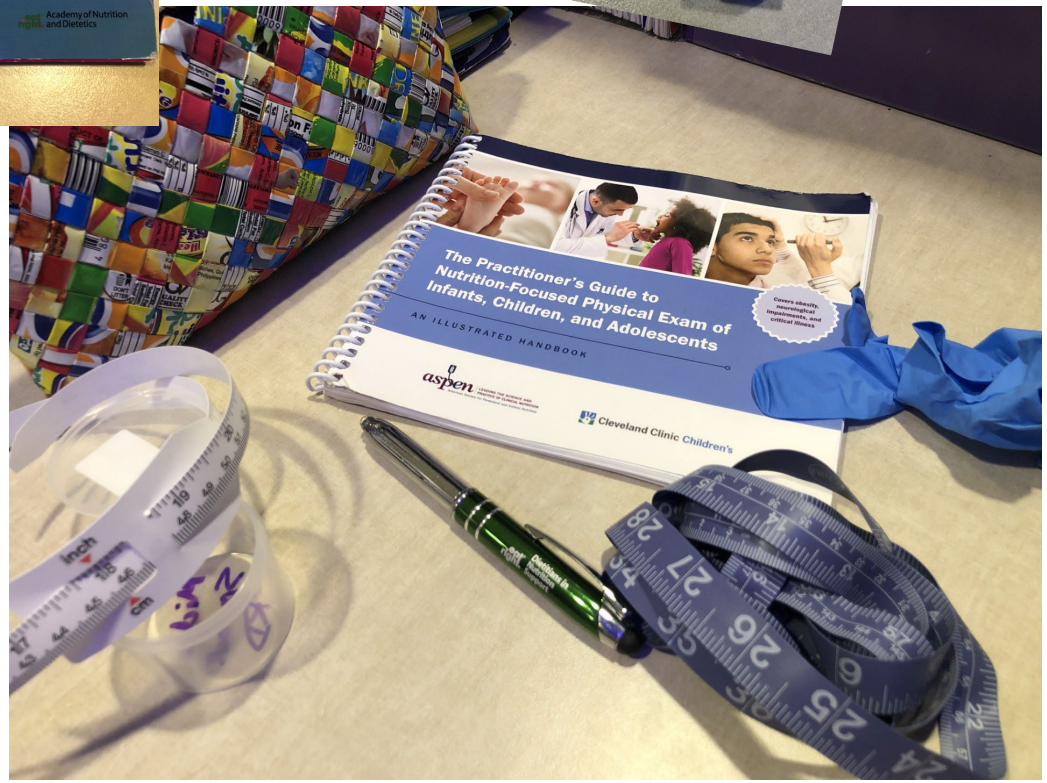
FIGURE 1 Key driver diagram summarizing project aim, key drivers, and change ideas tested. BMI, body mass index; EHR, electronic health record.

Persaud S, Hron BM, Rudie C, et al. Improving anthropometric measurements in hospitalized children: a quality-improvement project. Nutr Clin Pract. 2024;39:685-695. doi:10.1002/ncp.11112NUTRITION IN CLINICAL PRACTICE | 695

Pediatric NFPE tools

Tape measure
Head circumference tape
Tongue depressor
Penlight
Kid friendly toy (optional)





Pediatric NFPE Worksheet Example

Pediatric Nutrition Focused Physical Exam

		No deficit	Normal / Well nourished	Mild-Moderate	Severe	Other
Subq Fat Loss						
	Orbital		slightly bulging fat pads	Slightly dark circles, Somewhat hollow	Dark circles, Hollow depressions, loose/sagging skin	
	Buccal area		Full round cheeks	Flat cheeks, minimal bounce	Hollow, sunken cheeks	
	Upper Arm		Arms full and round, ample fat tissue	Some depth pinch, not ample	Very little space between folds, fingers touch	
	Ribs/Midaxillary (Thoracic and Lumbar region)		Chest is full, round with ribs not evident / minimal ability to visualize iliac crest	Ribs apparent with slightly visible depressions between them / iliac crest slightly visible	Progressive prominence of ribs with loss intercostal tissue / iliac crest very visible	
	Buttocks (infants and toddlers)		Full and round	Slightly curved, but not round	skin is wrinkled in appearance; no fat evident	
Muscle Loss						
	Temple		Well defined muscle, flat	Slight Depression	Deep hollowing, scooping, depression	
	Clavicle Bone		Clavicle may be present, not prominent	Visible in males; some protrusions in females	Protruding; shows prominence	
	Acromion Bone		Rounded curves at arms, shoulders and neck	Acromion process slightly protruding, shoulders not square	Shoulder to arm joints squared, acromion protruding	
	Scapular Bone and Spine regions		Bone not prominent; no depressions	Mild depression; spine or bone may show slightly	Prominent, visible scapula; spine depression is significant	
	Dorsal Hand (adult only)			Slightly depressed	very depressed	
	Anterior Thigh		well rounded, no depressions	Mild depression on inner thigh	Depression line on thigh; obviously thin	
	Patellar		Muscle protrudes; kneecap is not prominent	Knee cap more prominent; more rounded	Knee bones prominent; little signs of muscle around the knee	
	Calf		well developed bulb of muscle	less developed bulb of muscle	Thin; Little to no muscle definition	
	Fluid Accumulation		mild to moderate pitting; slight swelling; (0-30 seconds); + 1-2	Deep to very pitting; (31-60 sec); + 3-4	Ascites per chart	
Hand Grip Strength. *Use to get a good feel of strength and for encouragement. Note 1 Cannot use to dx malnutrition. Note 2 Check if on sedatives.*			strong firm		Weak and soft	unable to assess

Mid-upper Arm Circumference measurement:_____ cm **Arm Span:** _____ cm

References:

The Practioner's Guide to Nutrition-Focused Physical Exam of Infants, Children and Adolescents, ASPEN, 2019
Nutrition-Focused Physical Exam: An Illustrated Handbook, ASPEN, 2016

By Michele Spurlock, RD 3_2020

First Contact

Tips for Reducing Barriers in Pediatrics
Tips to prepare for exam of an infant or child:
Leave anxiety at the door
Start exam in a happy and playful manner
Be flexible; may need to finish exam at another time
Explain what you are doing; show equipment
Use simple, fun language
Be creative
Listen and include caregivers

Keep calm and rehearse your lines

Holmes CJ, Racette SB. The Utility of Body Composition Assessment in Nutrition and Clinical Practice: An Overview of Current Methodology. Nutrients. 2021;13(8):2493. Published 2021 Jul 22. doi:10.3390/nu13082493

Chisholm SA. 9 Tips and Tricks to Successfully Examine Kids (and Have Fun While Doing It!). American Academy of Ophthalmology. May 19, 2022. 9 Tips and Tricks to Successfully Examine Kids (and Have Fun While Doing It!) - American Academy of Ophthalmology (aao.org) Accessed 1/25/2024.

House R. Tricking Kids into the Perfect Exam: Tips for Evaluating the Pediatric Patient. Empediatrics - University of Florida, August-September 2008, pages 34-45. www.emergency.med.ufl.edu/files/2013/02/Tricking-Kids-into-the-Perfect-Exam.pdf Accessed January 25, 2024

Pregerson B. Pediatric Tricks of the Trade: What They Didn't Teach You in Residency. Patient Care Online. October 17, 2013. Pediatric Tricks of the Trade: What They Didn't Teach You in Residency (patientcareonline.com) Accessed 1/25/2024.

First Contact

Tips for Reducing Barriers in Pediatrics
<u>Tips to calm the infant or child:</u>
Make a game of exam
Tell a story
Ask the child what they are playing with, watching or reading
Keep neonates warm; re-bundle in blanket when finished; calm voice
For older infants and toddlers, “stranger danger” is an issue; speaking to parents first and avoid immediately putting them in the spotlight reduces their anxiety
For school-aged children, explain things before they happen
For teenagers, be respectful

It is ok to gently remind children and teens refocus. “Eyes on me please.”

Holmes CJ, Racette SB. The Utility of Body Composition Assessment in Nutrition and Clinical Practice: An Overview of Current Methodology. Nutrients. 2021;13(8):2493. Published 2021 Jul 22. doi:10.3390/nu13082493

Chisholm SA. 9 Tips and Tricks to Successfully Examine Kids (and Have Fun While Doing It!). American Academy of Ophthalmology. May 19, 2022. 9 Tips and Tricks to Successfully Examine Kids (and Have Fun While Doing It!) - American Academy of Ophthalmology (aao.org) Accessed 1/25/2024.

House R. Tricking Kids into the Perfect Exam: Tips for Evaluating the Pediatric Patient. Empediatrics - University of Florida, August-September 2008, pages 34-45. www.emergency.med.ufl.edu/files/2013/02/Tricking-Kids-into-the-Perfect-Exam.pdf Accessed January 25, 2024

Pregerson B. Pediatric Tricks of the Trade: What They Didn’t Teach You in Residency. Patient Care Online. October 17, 2013. Pediatric Tricks of the Trade: What They Didn’t Teach You in Residency (patientcareonline.com) Accessed 1/25/2024.

Stunted height

1. Assess height on WHO/CDC growth chart and, if applicable, specialty growth chart.

2. Ensure accurate measure.

3. If height is < -2 z-score:
    1. Estimate a child's adult height potential by calculating mid-parental height (MPH).
        MPH for females (cm) = average of parents' height in cm – 6.5
        MPH for males (cm) = average of parents' height in cm + 6.5
    2. Walk through decision tree for malnutrition stunted children.
    3. Determine IBW for this height at 50%ile of actual height.

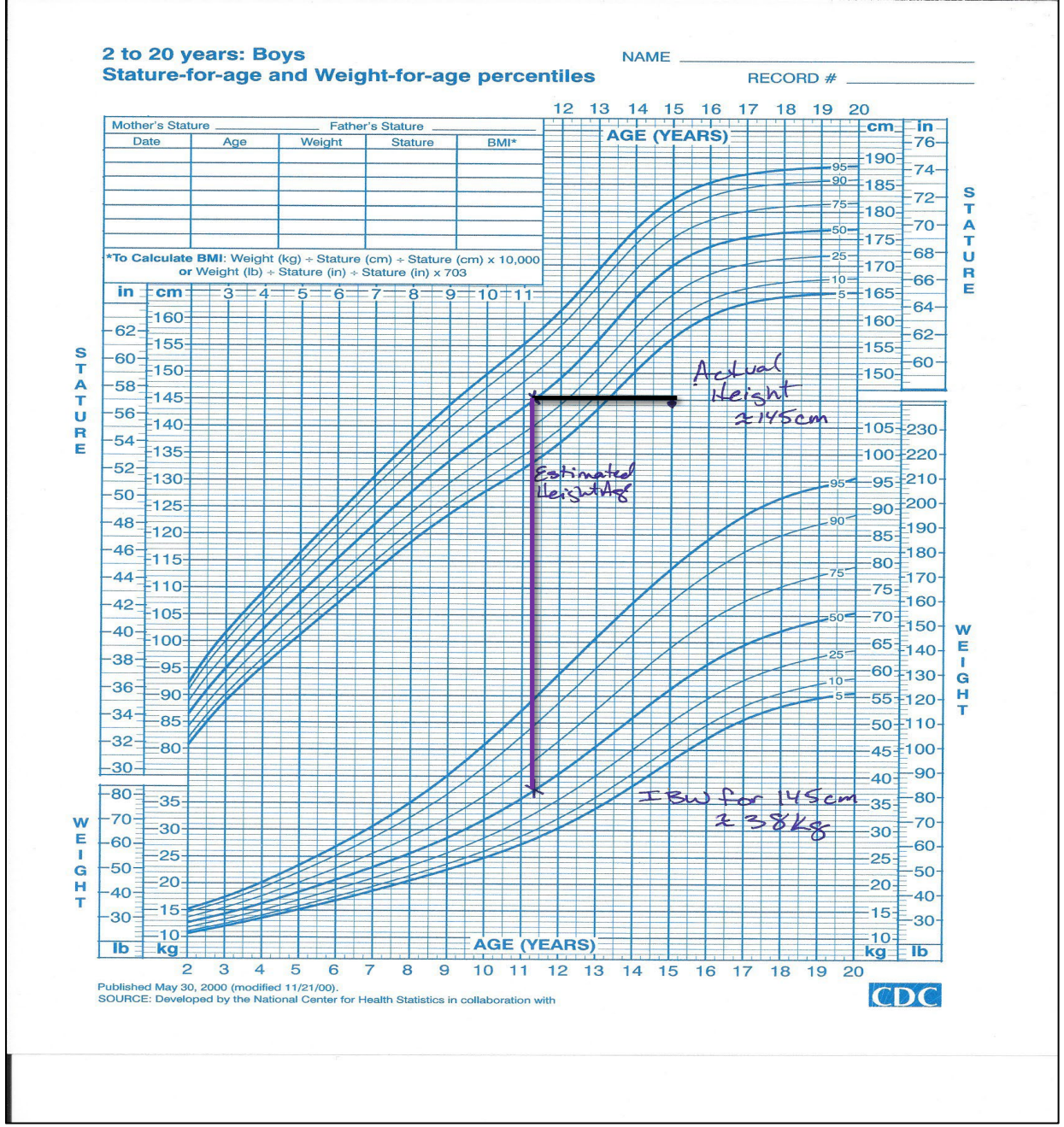
4. If concerned about stunting, can refer to Endocrine.

Tanner JM, Goldstein H, Whitehouse RH. Standards for children's height at ages 2-9 years allowing for heights of parents. Arch Dis Child. 1970 Dec;45(244):755-62. doi: 10.1136/adc.45.244.755. PMID: 5491878; PMCID: PMC1647404.

Stunted height

Age: 15-year Male

Height: 145 cm
Weight: 45 kg



1. Plot actual height.
2. Using ruler, draw line to meet 50th%ile and mark an “x”.
3. Using ruler again, draw line to 50th%ile on weight chart and draw “x”.
4. Using ruler again, draw line from weight 50th%ile to determine IBW for this height.

Stunted height

Billy Blue
Age: 15-year Male

Height: 145 cm 0% z-score < -3.19

Weight: 45 kg 5% z-score < -1.65

BMI: 21.4 66% z-score 0.41

IBW for age: 58.7 kg 76%

IBW for his height: 38 kg 118%

IBW shows that he is underweight.
Determining his IBW for his height, shows over IBW but < 125%.
Need NFPE and visual to determine shape.

Stunted height

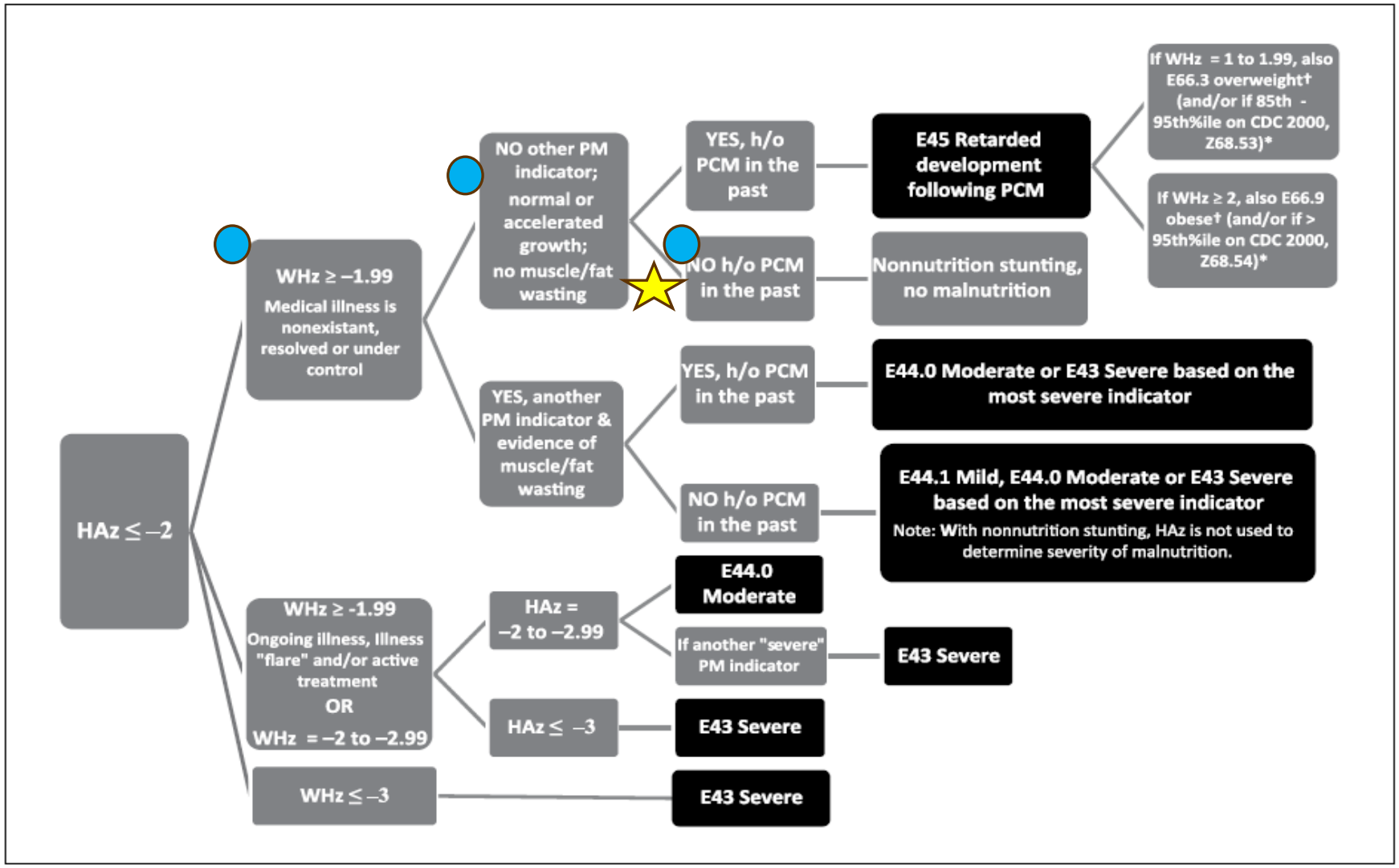


Figure 4. Decision tree for diagnosing malnutrition in stunted children according to *International Classification of Diseases, Tenth Revision* codes. Adapted with permission from MTool (addendum 1). %ile, percentile; CDC, Centers for Disease Control and Prevention; HAz, height/length-for-age *z* score; h/o, history of; PCM, protein-calorie malnutrition; PM, pediatric malnutrition; WHz, BMI/weight-for-length *z* score.

†de Onis M, Onyango AW, Borghi E, et al. Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ*. 2007:85:660-667.

*Kuczmarksi RJ, Ogden CL, Guo S, et al. 2000 CDC growth charts for the United States: methods and development. *Vital Health Stat*. 2002;11:1-190.

Body Composition

After infancy, fat density differs little at any specific age. Lean tissue varies depending upon hydration and proportions of muscle and bone, which also varies based age, sex, race, level of maturation, exercise and nutritional status.

Czerwinski, S., Choh, A., and Lee, M. "Growth and Maturation." *Samour & King's Pediatric Nutrition in Clinical Care*, edited by Susan H. Konek and Patricia J. Becker, 5th ed., Jones & Bartlett Learning, 2020, pp. 35-50.

	Definition
Total body mass	FM+FFM
Fat Free Mass (FFM)	LBM without fat
Fat Mass (FM)	Fat
Lean Body Mass (LBM)	composed of muscle, internal organs, bones, ligaments, tendons, water, and small amount of fat from bone marrow.
Body water	intracellular and extracellular water

Czerwinski, S., Choh, A., and Lee, M. "Growth and Maturation." Samour & King's Pediatric Nutrition in Clinical Care, edited by Susan H. Konek and Patricia J. Becker, 5th ed., Jones & Bartlett Learning, 2020, pp. 35-50.

Holmes, Clifton J., and Susan B. Racette. "The Utility of Body Composition Assessment in Nutrition and Clinical Practice: An Overview of Current Methodology." *Nutrients*, vol. 13, no. 8, 2021, p. 2493. https://doi.org/10.3390/nu13082493.

Body Composition

Body Composition Measurement Methods

Research only

Anthropometry	Lengths, circumferences, and skinfold thicknesses
Body volume/density	Hydrodensitometry/underwater weighing, air displacement plethsmography, 3D body surface imaging
Total body water/hydrometry	Tracer techniques using principle of dilution
Major body elements	Whole body counting and neutron activation analysis
Impedence: bioimpedance analysis (BIA)	Fluid and fluid changes (intracellular water, extracellular water, total body water, FM, FFM, and %Fat)
Imaging/x-ray attenuation	Dual energy x-ray absorptiometry (DXA/DEXA), ultrasound (US), computerized tomography (CT),magnetic resonance imaging (MRI), quantitative magnetic resonance (QMR), and quantitative computed tomography (QCT) imaging
Multicompartment models	Combination of methods that can include body volume, total body water, fat free mass, fat mass, and bone mineral content

Prado CM, Heymsfield SB. Lean tissue imaging: a new era for nutritional assessment and intervention [published correction appears in JPEN J Parenter Enteral Nutr. 2016 Jul;40(5):742]. JPEN J Parenter Enteral Nutr. 2014;38(8):940-953.

Body Composition

Method	Category	Measures	Considerations
3D body surface imaging	2-compartment	Digital image analysis to estimated body volume, size, circumferences at various anatomical locations	● Easy to use ● In-expensive ● Safe ● Limited availability of technique ● Can calculate additional anthropometric parameters ● Accurate estimation percentage of body fat ● Must be able to old breath for 10 seconds which may be limited in some patients with certain conditions and certain ages of patients
Hydrostatic weighing (HW)/Hydro-densitometry	2-compartment	FM and FFM	● Expensive ● Advanced equipment and setup ● Technical expertise needed ● Not feasible for those with aquaphobia or unable to hold their breath for a period or children
Stable isotope dilution/deuterium dilution (TBW)	2-compartment	Total body water, FM, FFM.	● Expensive equipment ● Requires specialized training and equipment ● Lengthy process, up to ~ 4 hours. ● Noninvasive and easy to carry out ● Suitable for infants and children, although they must be still/asleep ● Can overestimate total body fluid by 12-30% ● Relies on assumed hydration of FFM (73.2%)
Air Displacement Plethysmography (ADP)	2-compartment	Estimates body composition	● Expensive ● Large space required ● Least possible clothing and tightly fitted clothing with swim cap must be worn ● Excessive facial or body hair may introduce errors ● Children must be clinically stable with no oxygen support ● Children must enter and stay in a chamber and not move during the test, as it can take longer than adults ● Some devices can be used for infants

Prado CM, Heymsfield SB. Lean tissue imaging: a new era for nutritional assessment and intervention [published correction appears in JPEN J Parenter Enteral Nutr. 2016 Jul;40(5):742]. JPEN J Parenter Enteral Nutr. 2014;38(8):940-953.

Holmes, Clifton J., and Susan B. Racette. "The Utility of Body Composition Assessment in Nutrition and Clinical Practice: An Overview of Current Methodology." *Nutrients*, vol. 13, no. 8, 2021, p. 2493. https://doi.org/10.3390/nu13082493.

Body Composition

	Category	Measures	Considerations
Ultrasound (US)	2-compartment	Measures the quadriceps femoris muscle. Can differentiate between tissues, where air < adipose tissue < muscle < bone	● Safe ● Portable ● Inexpensive ● Reliable, reproducible, and accurate ● Personnel training ● Anatomical irregularities ● Allows early detection of muscle wasting
Bioimpedance Analysis (BIA)	3-compartment	Measurement of fluid and fluid changes, therefore whole-body FM and FFM by measuring the Phase Angle	● Accurate when performed by a trained assessor ● Portable ● May not be a suitable method for obesity (BMI > 34), critical illness, or fluid overload. ● Measure consistently in similar states of hydration ● Not recommended in people with implantable electronic devices
Computed tomography (CT) - *current gold standard for body composition*	3-compartment	Skeletal muscle, bone, visceral organs, and brain tissue.	● Expensive ● Radiation exposure ● High validity between scans ● Personnel training ● Large subjects cannot fit into the scanner
Magnetic resonance imaging (MRI)	3-compartment	FM, skeletal muscle, edema, and visceral organs	● Expensive ● Requires specific technical skills/ certificate for procedure and image analysis ● May require sedation ● Time consuming ● Not portable

Prado CM, Heymsfield SB. Lean tissue imaging: a new era for nutritional assessment and intervention [published correction appears in JPEN J Parenter Enteral Nutr. 2016 Jul;40(5):742]. JPEN J Parenter Enteral Nutr. 2014;38(8):940-953.

Holmes, Clifton J., and Susan B. Racette. "The Utility of Body Composition Assessment in Nutrition and Clinical Practice: An Overview of Current Methodology." *Nutrients*, vol. 13, no. 8, 2021, p. 2493. https://doi.org/10.3390/nu13082493.

Body Composition

Mid-upper arm muscle circumference (MAMC)

MAMC estimates somatic protein but not a good measure in persons with > 125% weight (obesity). MAMC is determined using TSF and mid-upper arm circumference (MUAC), and it is calculated by a nomogram developed by Gurney and Jelliff in 1973. Many use the acronyms MAMA/AMA interchangeably with MAMC.

$$\text{Muscle mass (MAMC)} = \frac{\text{MUAC (cm)} - (3.14 \times \text{TSF (mm)} / 10)}{12.56}$$

Heymsfield accounted for the bone in the above equation by:

Subtracting -6.5 females and -10 for males

Ekvall S, Ekvall V. Pediatric Nutrition in Chronic Diseases and Developmental Disorders: Prevention, Assessment, and Treatment. Oxford University Press; 2005.
Stephens K, Orlick M, Beattie S, et al. Examining Mid-Upper Arm Circumference Malnutrition z-Score Thresholds. Nutr Clin Pract. 2020;35(2):344-352. doi:10.1002/ncp.10324
Gurney JM, Jelliffe DB. Arm anthropometry in nutritional assessment: nomogram for rapid calculation of muscle circumference and cross-sectional muscle and fat areas. Am J Clin Nutr. 1973;26(9):912-915. doi:10.1093/ajcn/26.9.912
Heymsfield SB, McManus C, Smith J, Stevens V, Nixon DW. Anthropometric measurement of muscle mass: revised equations for calculating bone-free arm muscle area. *Am J Clin Nutr*. 1982;36(4):680-690. doi:10.1093/ajcn/36.4.680

Body Composition

Calf circumference (CC) estimates muscle mass.

This technique, which is simple to perform, involves finding the point with the widest circumference of the calf, with the individual's leg forming a 90° angle and feet flat.

A study by Chagas on pediatric oncology patients during outpatient follow-up found a strong correlation between CC and lower limb muscle strength and functionality. The findings suggest that measuring CC can predict deficits and indicate the onset of sarcopenia in young individuals undergoing treatment for childhood cancer. *No validation.*

Zamberlan P, Mazzoni BP, Bonfim MAC, Vieira RR, Tumas R, Delgado AF. Body composition in pediatric patients. Nutr Clin Pract. 2023;38 Suppl 2:S84-S102. doi:10.1002/ncp.11061
Chagas P, Goretti P, Marques R, et al. Association between calf circumference, muscle strength and functioning in children and adolescents with cancer - Preliminary study. Dev Med Child Neurol. 2021;63(Suppl 2):31.

Body Composition

Calf circumference (CC)

Vieira et al. Observed that CC decreased significantly within 1 week of PICU stay, unlike MUAC and weight. No correlation was found between the percentage change in CC at 1 week in the PICU and length of stay or death.

Kokku et al. First to use calf circumference to identify infants with low birth weight (LBW), and they showed the highest sensitivity and degree of correlation with birth weight. In this study, CC measures of less than 9.13 cm would be considered LBW with < 2.5 kg and less than 7.83 cm LBW with < 2 kg.

CC appears to be an interesting alternative for assessing muscle mass in pediatric patients. However, it may have some limitations in children and adolescents with neuromuscular diseases. Although there are no validated cutoff points for CC in pediatrics, it can be used to monitor the evolution of nutrition status within individuals.

Vieira RR, de Campos MMS, Zamberlan P, Viani K. Can calf circumference be a viable option for nutritional assessment in the PICU? Clin Nutr ESPEN. 2021;45:356-362.
Kokku PK. Calf circumference to detect low birth weight babies. International Journal of Contemporary Pediatrics. 2019;6(6). doi:10.18203/2349-3291.

Body Composition

In 1988, Slaughter and Lohman developed skinfold equations for estimating body fatness in children ages 8 – 18 using skinfolds of triceps and calf.

Slaughter equation

(triceps and calf measurement equation for children):

Male % body fat = 0.735 (triceps + calf) + 1.0

Female % body fat = 0.61 (triceps + calf) + 5.1

Slaughter MH, Lohman TG, Boileau RA, et al. Skinfold equations for estimation of body fatness in children and youth. Hum Biol. 1988;60(5):709-723.

Body Composition

Gurka et al. found that in children with cerebral palsy, the Slaughter equations underestimated Fat Mass.

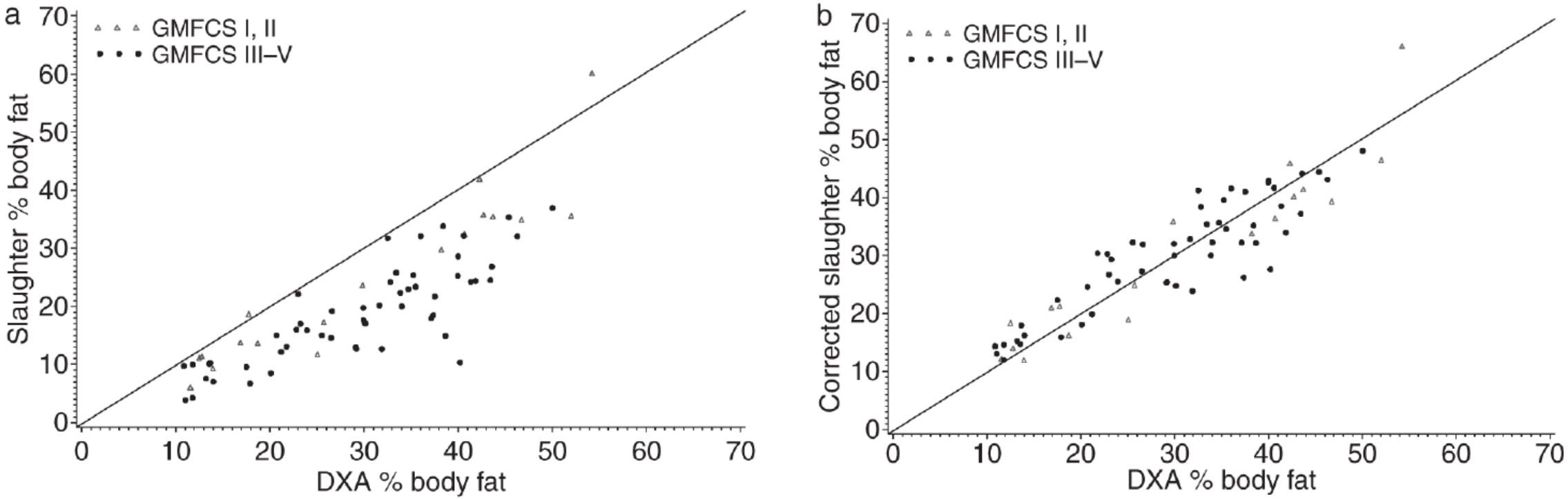
a
Prepubescent, Tanner stage 1, 2; pubescent, Tanner stage 3; postpubescent, Tanner stage 4, 5.
b
Instructions for using these corrections on a given child with CP: always add 12.2 to the Slaughter-estimated percentage body fat. Then, if the individual falls within each of the additional categories, add that respective correction as well.

For example, for a black pubescent male at GMFCS level 1 whose sum (triceps, subscapular)<35mm, the predicted percentage body fat=Slaughter percentage body fat +12.2−5.0−3.1+2.0. Tri + sub, triceps skinfold + subscapular skinfold. GMFCS, Gross Motor Function Classification System.

Gurka MJ, Kuperminc MN, Busby MG, et al. Assessment and correction of skinfold thickness equations in estimating body fat in children with cerebral palsy. Dev Med Child Neurol. 2010;52(2):e35-e41. doi:10.1111/j.1469-8749.2009.03474.x

Population	Original Slaughter equation for predicting percentage body fat[7]
Sum (triceps, subscapular)≤35mm	
Males	
Prepubescent[a] white	% Body fat=1.21(tri+sub)−0.008(tri+sub)^2 −1.7
Prepubescent black	% Body fat=1.21(tri+sub)−0.008(tri+sub)^2 −3.2
Pubescent white	% Body fat=1.21(tri+sub)−0.008(tri+sub)^2 −3.4
Pubescent black	% Body fat=1.21(tri+sub)−0.008(tri+sub)^2 −5.2
Postpubescent white	% Body fat=1.21(tri+sub)−0.008(tri+sub)^2 −5.5
Postpubescent black	% Body fat=1.21(tri+sub)−0.008(tri+sub)^2 −6.8
Females (all)	% Body fat=1.33(tri+sub)−0.013(tri+sub)^2 −2.5
Sum (triceps, subscapular)>35mm	
Males (all)	% Body fat=0.783(tri+sub)+1.6
Females (all)	% Body fat=0.546(tri+sub)+9.7
	Cerebral-palsy-specific corrections to Slaughter-estimated percentage body fat[b]
Overall correction	+12.2
Additional correction for	
Males	−5.0
More severe GMFCS	+5.1
Black race	−3.1
Pubescent	+2.0
Postpubescent	−4.6
Sum (triceps, subscapular) >35mm	−3.2

Body Composition



Slaughter equations (a) original and (b) corrected versus dual energy X-ray absorptiometry (DXA) for percentage body fat. GMFCS, Gross Motor Function Classification System.

Clinical Use of MUAC

Measurement challenges
Neurological impairment, contractures, inability to stand
Asymmetry (limb amputation, malformation, atrophy, or hypertrophy)
Kyphoscoliosis
Hydrocephalus
Durable medical equipment, casts
Critically ill

Malnutrition risk, cachexia due to increased requirements, decreased intake
Congenital heart disease
Cystic Fibrosis
Cancer
Eating Disorders
Malabsorption

Iatrogenic weight gain
Fluid Shifts, renal, cardiac
Steroid use
Other medications, in vitro fertilization

Patients who dislike being weighed or measured
Overweight/obesity
Eating Disorders
Intellectual disability
Autism

Lack of access to calibrated equipment or inaccurate measurements
Remote consultations/telehealth
Community healthcare workers
Underresourced settings
High Patient volume settings (may not check height routinely)

Serial measurement
Repeated MUAC may be more sensitive to treatment success
Parents can measure serially

Becker P, Abdel-RahmanS, Nemet D, et al. Measurement of mid-upper arm circumference to screen for childhood malnutrition: general applicability and use in special populations. Nutr Clin Pract.2024;39:1517-1528. doi:10.1002/ncp.112081528 | BECKER ET AL .
Miles C, Fox J, Davis K,et al. Utility of mid-upper arm circumference in pediatric malnutrition: an Australasian Society of Parenteral and Enteral Nutrition consensus statement using the Delphi method. Nutr ClinPract. 2024;39:1529-1552. doi:10.1002/ncp.112051552 | MILES ET AL .

Body Composition

Factors that could influence the MUAC value and its accuracy:

- Which arm used
- Sitting or Supine
- Method of measure (WHO or International Society for the Advancement of Kinanthropometry (ISAK)
- Arm is bent or relaxed
- How many times measurement is repeated
- Type of tape used

MUAC measurements should be performed using an inelastic measuring tape, or specific MUAC tape, at the midpoint of the upper nondominant arm. The midpoint of the upper arm is located halfway between the acromion (shoulder tip) and olecranon (elbow tip). The following technique should be followed when measuring MUAC:

1. MUAC measurements should be taken from the nondominant arm.
2. Ensure the upper arm is bare.
3. Bend the arm to 90°.
4. Locate the shoulder tip and elbow tip and mark with a pen.
5. With an inelastic measuring tape, or specific MUAC tape, measure the midpoint and mark this point with a pen.
6. Straighten the arm.
7. Place the tape around the arm at the midpoint.
8. Pull the tape until it is snug but does not compress the skin or muscle.
9. Record your measurement to the nearest 0.1 cm.

Becker P, Abdel-RahmanS, Nemet D, et al. Measurement of mid-upper armcircumference to screen for childhoodmalnutrition: general applicability and use inspecial populations. Nutr Clin Pract.2024;39:1517-1528. doi:10.1002/ncp.112081528 | BECKER ET AL .
Miles C, Fox J, Davis K,et al. Utility of mid-upper arm circumference inpediatric malnutrition: an Australasian Societyof Parenteral and Enteral Nutrition consensusstatement using the Delphi method. Nutr ClinPract. 2024;39:1529-1552. doi:10.1002/ncp.112051552 | MILES ET AL .

Body Composition

Used around the world. WHO standard: < 125mm in children aged 6-60 months, indicates malnutrition.

Document z-scores is preferred. Can track actual values and percentages if unable to obtain z-scores.

Current standard below shows nutrition status by color of one MUAC measuring tape and by MUAC z-score range which can be calculated on PediTools.com.

REFERENCE TABLE FOR Z-SCORE RANGES ON TAPE		
Color/Pattern Key	MUAC Z-score Range	Risk Classification
Solid Orange	2 to 3	Moderate Overnutrition
Solid Yellow	1 to 2	Mild Overnutrition
Solid Green	0 to 1	Normal
Hashed Green	-1 to 0	Normal
Hashed Yellow	-2 to -1	Mild Undernutrition
Hashed Orange	-3 to -2	Moderate Undernutrition
Hashed Red	-4 to -3	Severe Undernutrition

Becker P, Abdel-Rahman S, Nemet D, et al. Measurement of mid-upper arm circumference to screen for childhood malnutrition: general applicability and use in special populations. Nutr Clin Pract.2024;39:1517-1528. doi:10.1002/ncp.112081528 | BECKER ET AL .

Miles C, Fox J, Davis K,et al. Utility of mid-upper arm circumference in pediatric malnutrition: an Australasian Society of Parenteral and Enteral Nutrition consensus statement using the Delphi method. Nutr Clin Pract. 2024;39:1529-1552. doi:10.1002/ncp.112051552 | MILES ET AL .

MUAC in Preterm and Term Infants:

Ashton et al developed MUAC growth curves for preterm< 30 weeks gestational age. Determined MUAC is feasible, reproducible and showed high concordance with wt, lt and HC in this population.

Hoehn et al found that Wt and MUAC had lower measurement errors than length.

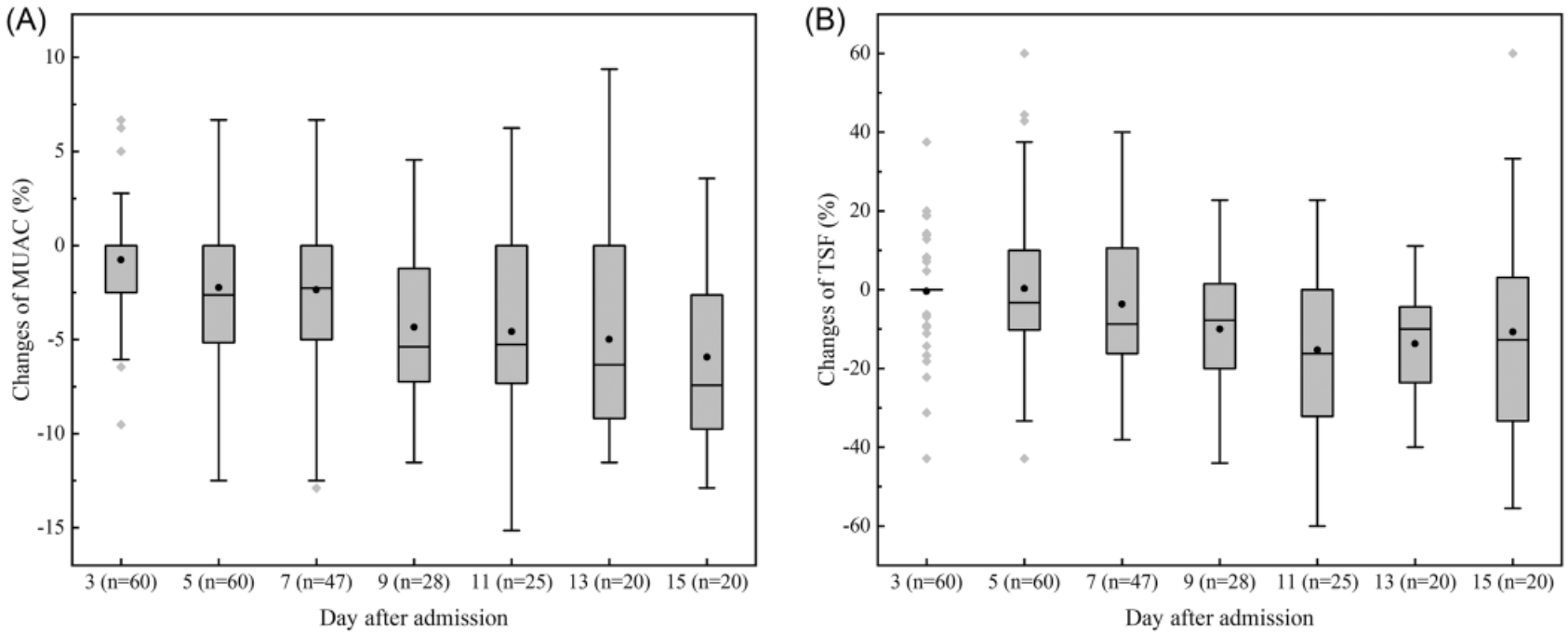
Yousuf et al showed for infants < 6 months, MUAC significantly associated with fat mass but weakly with LBM compared to ADP

WHO guidelines for infants 6 weeks to < 6 months: MUAC < 110 mm should prompt for nutrition assessment.

Ashton JJ, Johnson MJ, Pond J, et al. Assessing the growth of preterm infants using detailed anthropometry. Acta Paediatr (Stockholm). 2017;106(6):889-896. doi:10.1111/apa.13804
Hoehn C, Lelijveld N, Mwangome M, Berkley JA, McGrath M,Kerac M. Anthropometric criteria for identifying infants under 6 months of age at risk of morbidity and mortality: a systematic review. Clin Med Insights Pediatr. 2021;15:11795565211049904.
Yousuf EI, Rochow N, Li J, et al. Growth and body composition trajectories in infants meeting the WHO growth standards study requirements. Pediatr Res. 2022;92(6):1640-1647.
Daly-Wolfe KM, Jordan KC, Slater H, Beachy JC, Moyer-Mileur LJ. Mid-arm circumference is a reliable method to estimate adiposity in preterm and term infants. Pediatr Res.2015;78(3):336-341.
WHO. WHO Guideline on the Prevention and Management of Wasting and Nutritional Oedema (Acute Malnutrition) in Infants and Children Under 5 Years. WHO Press; 2023.

Body Composition

Measured MUAC and TSF during PICU admission. Concluded that MUAC trend reflected adequacy of nutrition support.



Zhang Y, Fang Z, Zhao X,Zhu X, Zhu Y, Feng Y. Monitoring MUAC reflects the adequacy of nutrition support in critically ill children with a longer intensive care unit stay: a single-center prospective cohort study. Nutr Clin Pract. 2025;1-11. doi:10.1002/ncp.11289NUTRITION IN CLINICAL PRACTICE | 11

Function

Functional capacity in infants and children can be assessed by activities of daily living (ADLs), play and the changes in their activity/play.

Secker and Jeejeebhoy determined that assessing functional status can assist in clarifying between a usually thin child with an abundant amount of energy and a child that has lost weight due to decreased intake, which can affect the ability to play/perform.

Functional Capacity (nutritional related)	
1	no impairment, energetic, able to perform age-appropriate activity
2	restricted in physically strenuous activity, but able to perform play and/or school activities in a light or sedentary nature; less energy; tired more often
3	little or no play or activities, confined to bed or chair > 50% of waking time; no energy; sleeps often

Secker DJ, Jeejeebhoy KN. How to perform Subjective Global Nutritional Assessment in children. J Acad Nutr Diet. 2012 Mar;112(3):424-431.e6. doi: 10.1016/j.jada.2011.08.039. Epub 2012 Mar 1. PMID: 22717202.

Secker DJ, Jeejeebhoy KN. How to perform Subjective Global Nutritional Assessment in children. J Acad Nutr Diet. 2012 Mar;112(3):424-431.e6. doi: 10.1016/j.jada.2011.08.039. Epub 2012 Mar 1. PMID: 22717202.

Function

Handgrip strength

- Reflects the strength of the upper extremities
- Low intraindividual variability
- Responds to nutrition deprivation and repletion before
- An important indicator of nutrition status
- Not a measure of body composition

Norman K, Stobäus N, Gonzalez MC, Schulzke JD, Pirlich M. Hand grip strength: outcome predictor and marker of nutritional status. Clin Nutr. 2011;30(2):135-142.
Silva C, Amaral TF, Silva D, Oliveira BMPM, Guerra A. Handgrip strength and nutrition status in hospitalized pediatric patients. Nutr Clin Pract. 2014;29:380-385.

Function

Handgrip strength

- According to the American Society of Hand Therapists, HGS measurement is performed using a dynamometer, and the handle must be adjusted according to the child's hand size, preferably using the dominant hand to reach maximum strength.
- The child must be seated with the shoulder in a neutral position, the elbow flexed at 90°, and the wrist in a neutral position.

Silva C, Amaral TF, Silva D, Oliveira BMPM, Guerra A. Handgrip strength and nutrition status in hospitalized pediatric patients. Nutr Clin Pract. 2014;29:380-385.
Leong DP, Teo KK, Rangarajan S, et al. Prognostic value of grip strength: findings from the Prospective Urban Rural Epidemiology (PURE) study. Lancet. 2015;386(9990):266-273.

Function

Handgrip strength

- Strong associations between HGS and anthropometric parameters in children
- No established reference data exist for hospitalized pediatric patients

Zamberlan P, Delgado AF, Leone C, Feferbaum R, Okay TS. Nutrition therapy in a pediatric intensive care unit: indications, monitoring, and complications. JPEN J Parenter Enteral Nutr. 2011;35(4):523-529.
Silva C, Amaral TF, Silva D, Oliveira BMPM, Guerra A. Handgrip strength and nutrition status in hospitalized pediatric patients. Nutr Clin Pract. 2014;29:380-385.

In undernutrition, the loss of body protein has numerous negative implications on muscle strength and functional status, and in hospitalized children, these conditions become more severe and increase morbidity and mortality.

Norman K, Stobäus N, Gonzalez MC, Schulzke JD, Pirlich M. Hand grip strength: outcome predictor and marker of nutritional status. Clin Nutr 2011;30(2):135-142.

Need standardization for assessment to allow applicability and reference parameters for hospitalized children and adolescents.

Sexual maturation

Age of onset varies by:

- Genetics
- Medical conditions
- Medical therapies
- Obesity/overnutrition - associated with early puberty.
- Undernutrition - associated with delayed puberty.

Corkins MR, Balint J. A.S.P.E.N. Pediatric Nutrition Support Core Curriculum (2nd Ed.). American Society for Parenteral and Enteral Nutrition; 2015.

Miller BS, Sarafoglou K, Addo OY. Development of Tanner Stage-Age Adjusted CDC Height Curves for Research and Clinical Applications. J Endocr Soc. 2020;4(9):bvaa098. Published 2020 Jul 17. doi:10.1210/jendso/bvaa098

Sexual maturation

Tanner Scale (also known as the Tanner Development Scale or the Tanner Growth Chart) describes pubertal changes by age and sex.

Characteristics: Pubic hair growth, either breast or genital development and increase in testicular volume or onset of menarche

The clinical rating scale is 1 = preadolescent to 5 = mature for each sex

Peterson et al developed the Pubertal Development Scale (PDS) as a non-invasive way to assess adolescent puberty PDS is a questionnaire given to parents and child.

Questions: growth in height, skin and voice changes, body and facial hair changes, breast changes, and age of menstruation.
Koopman-Verhoeff et al found that PDS tracks with the Tanner Scale.

Tanner JM. Growth at Adolescence: With a General Consideration of the Effects of Hereditary and Environmental Factors upon Growth and Maturation from Birth to Maturity. Blackwell Scientific Publications; 1962.

Corkins MR, Balint J. A.S.P.E.N. Pediatric Nutrition Support Core Curriculum (2nd Ed.). American Society for Parenteral and Enteral Nutrition; 2015.

Sonneville K, Duggan C. Manual of Pediatric Nutrition. 5th ed. People's Medical Publishing House; 2014.

Petersen AC, Crockett L, Richards M, Boxer A. A self-report measure of pubertal status: Reliability, validity, and initial norms. J Youth Adolesc. 1988;17(2):117-133. doi:10.1007/BF01537962

Koopman-Verhoeff ME, Gredvig-Ardito C, Barker DH, Saletin JM, Carskadon MA. Classifying Pubertal Development Using Child and Parent Report: Comparing the Pubertal Development Scales to Tanner Staging. J Adolesc Health. 2020;66(5):597-602. doi:10.1016/j.jadohealth.2019.11.308

Sexual maturation

Miller et al. developed a tool that properly categorizes growth patterns in children with normal variants of puberty (early and late). It also allows for projecting adult height potential and can identify potential under and overnutrition to better interpret height trends.

Interesting concept to consider when interpreting height; include Tanner Stage in assessment.

Not validated.

Miller BS, Sarafoglou K, Addo OY. Development of Tanner Stage-Age Adjusted CDC Height Curves for Research and Clinical Applications. J Endocr Soc. 2020;4(9):bvaa098. Published 2020 Jul 17. doi:10.1210/jendso/bvaa098

Sexual maturation

Case example:
India Indigo
12yo female
CF, malnourished, newly diagnosed CFRD.
Concern for eating disorder as found she thrived on her friends compliments on her thinness.
She refused her enzymes at school.
With this exam it was found that she was Tanner Stage 1 and had not started to menstruate yet.

GT placed, started enteral feeds and insulin.
Referred to Psychologist.

After ~ 18 months, she gained weight, started wearing a bra, carrying a purse, being responsible for her medications and feeds at school and started her period.

Sexual maturation

Lesson learned:

Pubertal stage is an essential physical finding but must be considered with the child’s global picture. One cannot say that child is malnourished since has not gone through puberty but can say that if malnourished, puberty can be delayed or early.

Developmental milestones - Ages Birth to 5 years

Five Main Domains

- Social/Emotional
- Language (Speech/Hearing /Communication)
- Gross Motor
- Fine Motor/Visual
- Cognitive (learning, thinking, problem-solving, understanding)

Other areas of concern depending upon which reference using:

- Self Help (Dressing/Grooming)
- Feeding/Swallowing

Developmental milestones: Feeding Skills

Age	Feeding Skill
Birth	Sucking, rooting, moves tongue in and out and up and down
1 month	Sucks well
2 months	Opens mouth at sight of bottle/human
3 months	Brings hands to mouth
4 months	Briefly holds on to breast or bottle
5 months	Transfers objects from hand to mouth
6 months	Places hands on bottle
7 months	Refuses excess food
8 months	Holds own bottle, finger feeds
9 months	Bites, chews food
10 months	Drinks from cup held for child
11 months	Stirs with spoon
12 months	Finger feeds parts of meal
15 months	Drinks from cup with some spilling, uses spoon with some spilling
18 months	Drinks from cup independently
24 months	Uses a straw
3 years	Independent eating, pours liquid from one container to another
4 years	Uses tongs to transfer, washes hands/face
5 years	Spreads with knife
> 6 years	Assisting with meal preparation and shopping

Source: adapted from Scharf R, Scharf G, Struoustrup A. Developmental Milestones. Pediatr Rev. 2016; 37: 25-38.
Table from Pediatric Nutrition for Dietitians Goday. Chapter 3, table 3.3 pages 39-40.

Smith, Jennifer L., and Teresa A. Capello. “Nutrition Screening and *ADIME*.” *Pediatric Nutrition for Dietitians*, CRC Press, Boca Raton, FL, 2022, pp. 35–50.

Developmental milestones

Ages 6 - 12 years (School Age) and 13 – 18 years (Adolescents)

Both continue to improve developing their motor and cognitive abilities.
(Time, Abstract thinking, Friends)

Developmental milestones

A substantial body of research has demonstrated that malnutrition can lead to abnormal brain development, leading to lasting cognitive impairment, affecting attention, visual, auditory, memory, and executive function, and interfering with a child's school performance and potential achievement.

Functional or developmental outcomes affected by malnutrition include decreased mobility, muscle loss, and weakness, which can lead to vent dependence, cognitive and developmental delays that can continue later in life even after malnutrition is corrected.

Driggers J Chapter 1, Goday PS, Walia C. Pediatric Nutrition for Dietitians. 1st ed. Taylor & Francis Group; 2022. Green Corkins K, Teague EE. Pediatric Nutrition Assessment: Anthropometrics to Zinc. *Nutr Clin Pract*. 2017;32(1):40-51. doi:10.1177/0884533616679639

Developmental milestones for a term 9-month-old

Social/Emotional	Is shy, clingy, or fearful around strangers
	Shows several facial expressions, like happy, sad, angry, and surprised
	Looks when you call her name
	Reacts when you leave (looks, reaches for you, or cries)
	Smiles or laughs when you play peek-a-boo
Language/ Communication	Makes a lot of different sounds like “mamamama” and “babababababa”
	Lifts arms up to be picked up
Cognitive (learning, thinking, problem-solving)	Looks for objects when dropped out of sight (like his spoon or toy)
	Bangs two things together
Movement/Physical	Gets to a sitting position by herself
	Moves things from one hand to her other hand
	Uses fingers to “rake” food towards himself
	Sits without support

Nervous System

- Nutritional neuropathies manifest either acutely, sub-acutely, or chronically.
- Malnutrition can affect the nervous system.
- Micronutrient deficiencies or toxicities can affect the nervous system.

Hammond N, Wang Y, Dimachkie MM, Barohn RJ. Nutritional neuropathies. Neurol Clin. 2013;31(2):477-489. doi:10.1016/j.ncl.2013.02.002

- Unrecognized effects of postnatal or childhood malnutrition on long term / long lasting neurodevelopment deficits (low IQ, poor school performance, and behavioral problems).

- Long term effects of malnutrition are associated not with type and severity of childhood malnutrition but also its duration.

Galler JR, Bringas-Vega ML, Tang Q, et al. Neurodevelopmental effects of childhood malnutrition: A neuroimaging perspective. *Neuroimage*. 2021;231:117828. doi:10.1016/j.neuroimage.2021.117828

Nervous System

Read or listen to Neuro Buzz words.

Neuro Checklist:

Memory Impairment: Dementia, memory loss, Wernicke's Encephalopathy, attention deficit, hyperirritability/irritability.

Cognitive impairment: Lethargy, MAS, global confusion/ confusion, mood changes, depression, delusions, overt psychosis. Note any changes in educational performance.

Muscle control poor: gait ataxia, sensory ataxia, lower extremity motor weakness, facial droop, uneven smile, Tongue deviation, eye movements, not able to raise/move eyebrow.

Muscle pain/cramps: myositis, muscle cramps, bilateral calf tenderness.

Fatigue, Weakness.

Numbness, tingling, burning loss of sensation, peripheral neuropathy, loss of proprioception, paresthesia. (lips, tongue, fingers, feet, legs.)

Twitching, tetany: muscle spasms, carpopedal, facial musculature spasm, restless leg.

Esper DH. Utilization of nutrition-focused physical assessment in identifying micronutrient deficiencies. *Nutr Clin Pract*. 2015;30(2):194-202. doi:10.1177/0884533615573054
Kilde K, et al. Support Line. 2016;38(4):3-9.

Nervous System

Case Study

17 yo male
Admit dx: DKA due to non-compliance
Weight: 55 kg 11% - 1.23 z-score
Height: 181 cm 77% 0.73 z-score
BMI: 16.8 0% - 2.41 z-score
Last weights: 6 months ago: 68 kg 9 months ago: 73 kg 25% change.

Examined him. At beginning of NFPE, asked him to smile to see his teeth. Right side did not move. Requested that he repeat it; when unable to fully smile, I asked him why he was unable to smile. He said that he has been unable to move his right side since the night before.

RN started neuro exam. I went to find the physician.

Subsequent dx: stroke, clots around infection in face/jaw/neck with a long hospital/rehab stay.

Nervous System

- Check for the infant/child's baseline.
- Note any psychiatric or behavioral issues.
- During NFPE, ask child to smile, to see their teeth, stick out and move their tongue, and wiggle eyebrows. (limited cranial nerve assessment)

If note concerns for stroke, immediately alert nurse and physician for full neurologic exam.

If concerned about malnutrition/micronutrient deficiency or toxicity related to neurologic symptoms, collaborate with medical team.

Micronutrients

Common Pediatric Diagnoses and Possible Nutrient Deficiencies

Condition/Diagnosis	Possible Nutrient Deficiencies	Increased Nutrient Needs
Burn/Poor Wound Healing	Vitamin C, vitamin A, zinc, PCM	Vitamin C, B-complex, Potassium, Nitrogen
Cancer	PCM	
Chronic diarrhea	Zinc	
Chylothorax	EFAD, protein deficiency, zinc	
Congenital heart defects	PCM	
Cystic Fibrosis	Fat-soluble vitamins (A,D,E,K), protein-calorie malnutrition (PCM)	
Drugs		Vitamin C, Nitrogen, Sodium, Potassium, Vitamin B-12, Folic Acid
Emotion		Iodine, Vitamin C, B-complex, Calcium, Nitrogen
Environment (heat)		Calcium, Copper, Manganese, Phosphorus, Potassium, Iron, Nitrogen, Sodium
Immobilization		Calcium, Sodium, Potassium, Nitrogen, Water
Infections		Vitamin A, Vitamin C, Iron, Nitrogen, Calories, Water, Sodium, Potassium
Inflammatory bowel disease	Iron, folate, selenium, magnesium, zinc, calcium, vitamin D	
Intestinal Failure	With fat malabsorption: fat-soluble vitamins (A,D,E,K), zinc, calcium, magnesium	
	Ileal resection: vitamin B12	
	Duodenal involvement: iron, folate	
Liver disease	Vitamin K, essential fatty acid deficiency (EFAD)	
Physical Activity		Vitamin C, B-complex, Nitrogen
Prematurity	Vitamin D, calcium	
Renal	Zinc, copper, iron, magnesium	
	with dialysis: water-soluble vitamins	

Corkins, Kelly "Nutrition-Focused Physical Examination in Pediatric Patients." Nutrition in Clinical Practice, vol. 30, no. 5, 2015, pp. 640-646. https://doi.org/10.1177/0884533615591602.

Ekvall S, Ekvall V. Pediatric Nutrition in Chronic Diseases and Developmental Disorders: Prevention, Assessment, and Treatment. Oxford University Press; 2005.

Micronutrients

Dietary Reference Intakes (DRI)

Micronutrient Adequate Intake (AI) for Infants 0-6 months is derived from exclusively breastfed infants from well nourished mothers.

Reference data for children and adolescents is extrapolated from adult data.

Limited data on micronutrient body reserves and not clear but probably adult based and not of a growing body.

Some newer micronutrients have roles with growing infants and young children: choline, DHA. Limited information on or clear consensus on recommendations.

Key nutrients integral for the first 1000 days of life to prevent deficiencies and allow for optimal cognitive development:

1. Breastfed infants: iron, zinc, iodine, Vitamin B12 and Vitamin D.

2. Infants 6 months – toddlers 24 months: B-vitamins- folate, B6 and B12; vitamin A and D, Calcium, iron and zinc, omega 3 FA (optimal ratio of omega3: omega6), choline and iodine. ASPEN

https://www.canada.ca/content/dam/hc-sc/migration/hc-sc/fn-an/alt_formats/hpfb-dgpsa/pdf/nutrition/dri_tables-eng.pdf
The First 1,000 Days: Nourishing America's Future. https://thousanddays.org/wp-content/uploads/1000Days-NourishingAmericasFuture-Report-FINAL-WEBVERSION-SINGLES.pdf.2016.
Beluska-Turkan K, Korczak R, Hartell B, et al. Nutritional gaps and supplementation in the first 1000 days. Nutrients. 2019;11(12):2891.

Micronutrients

- **Any disruption** (cancer, trauma, critical illness, decreased intake, malnutrition) in nutrition status, **can affect growth velocity particularly at pivotal growth times**. Usually think of calories and protein, need to consider micronutrients as well.

- If mom is deficient, then baby is probably deficient.

- Some presentations may be different:
  a. Vitamin C in young toddlers and young children causing decreased ability to walk. Agarwal
  b. B-6/Pyridoxine deficiency can present in infants as seizures. Pearl
  c. Are there others? Research is based on humans (adults) that are not growing anymore.

- Unrecognized effects of postnatal or childhood malnutrition on long term / long lasting cognitive and neurodevelopment. Galler

Micronutrients Concerns

1. Limited data in micronutrient supplementation during CRRT in pediatrics; no guidelines.

2. If taking formula + vitamin + individual supplements, need to consider upper limit/toxicity and monitor. TUL amounts are different by age.

3. Discussion amongst some Pediatric Ketogenic RDs regarding concern for vitamin C Deficiency. Do we understand micronutrients when change intake for certain conditions?

4. Regarding SBS, unless in NICU, may struggle to find out what was removed to create a plan to monitor micronutrients.

5. If neoplastic treatment includes methotrexate FOR an infant, what do you use as a reference for folate intake?

Micronutrients Concerns

This is not meant to call out any formula/formula company but to make professionals aware of differences and potential areas to monitor.

Not all formulas are the same regarding micronutrient content. Formulas contain various amounts (or none) of micronutrients. Some companies state volume needed to meet estimated needs (DRI) by age.

a. WHO states 750 mL human milk to reach thiamine DRI. FTT or malnourished infants not getting volume > 750 mL. Does this hold true for other micronutrients?

b. Infant formulas do not state volume needed to meet DRI.

c. One PKU formula contains no B-12.

d. One blended food formula contains very low sodium amounts; another contains low calcium.

e. Any formula that is dosed low for caloric restriction is below minimal to meet DRIs, particularly electrolytes. Complications with monitoring sodium with various conditions/feeding regimens.

Micronutrients

		Deficits?	Possible Nutrient Finding	Possible non-nutrient causes
Hair				
	Alopecia (hair thinning or loss)		Protein, zinc and or biotin def diffuse loss (including eyebrows); EFA or selenium	Male pattern baldness, hypopituitarism, hypothyroidism, cancer tx, chemical alteration, infection, psoriasis, cushing ds, medication
	lightened hair color		Copper, selenium, EFA def, protein def	chemical alteration
	Corkscrew hair (located on arms and legs)		copper, vitamin C - follicular hyperkeratosis from scurvy in elderly	chemical alteration
	Lanugo		Energy deficiency	therapeutic steriod use; endocrine disorders
Eyes				
	Nasolabial seborrhea (scaling around the nostrils)		Vitamin B2, B3, B6	Tuberous sclerosis
	Dull, dry membrane with foamy spots (black, grey, white)		Vitamin A Bitot's spot	Pinguecula (elderly), Gaucher dx, pterygium
	Keratomalacia (hazy cornea)		Vitamin A	Hyperthyriodism
	Burning, itching eyes with photophobia		Riboflavin	Allergies and eye infections
	Pale conjunctivae		Iron, Folate, B12, Copper	Low cardiac output states

Micronutrients

Case Study

9-month-old Female
Admit Dx: anemia, recurrent illness
PMHx: 26-week prematurity, SBS, TPN dependent. Discharged NICU 4.5 months ago.

Labs: ↓Hgb, Hct, MCH, MCV, MCHC ↑RDW.

Reviewed home TPN order; noted no iron supplement order and high zinc dosage.
Zinc dosage was higher than normal in NICU due to high ostomy output and prematurity.

Micronutrients
Case Study

		Toxicity
Zinc		gastric distress, nausea, dizziness
		decreased immune function
		decreased levels of HDL
		impaired neutrophil and lymphocyte function
		UTI
		copper deficiency
		corkscrew hair (located on arms)

		Deficiency
Copper		hypopigmentation of skin
		Lightened hair color / lack luster
		Hypopigmentation of hair also known as swan neck hairs as grey / Menke's syndrome - steely hair
		corkscrew hair (located on arms)
		neutropenia

		Deficiency
Iron		fatigue / poor pallor
		tachycardia
		koilonychia (spoon shaped), central ridging
		pale nail beds
		Pale palpebral conjunctiva
		poor cap refill
		angular cheilitis (fissure, dry lips)
		glossitis (inflammation of the tongue, magenta tongue)
		pale tongue
		pale gum color
		Cheilosis (fissuring and dry scaling of the vermilion surface of the lips and angles of the mouth)
		inflamed oral mucosa / Stomatitis (Mouth/lip inflammation)
		Beefy red tongue
		Atrophic glossitis
		Central ridging on nails

√

Micronutrients
Case Study

Labs results indicated iron and copper deficiency due to zinc toxicity.

Treatment: decreased zinc level in TPN. Started monthly iron infusions.

Lessons learned:
1. Micronutrient recommendations should have end dates in both recommendations and in orders.
2. Good continuity of care with Infusion Company and GI Clinic for new orders.

Forming habits

Add NFPE to your practice when concerned about malnutrition/degree of malnutrition.

PAUSE and check the infant/child.

Add NFPE to your daily task list/sheet/nutrition screen/intake to highlight its importance.

Add to your resources of books, copy articles or good tables and put into easy access location. I use a NFPE handbook and simply tape information into the book. Keep all in one place.

Assessment 2.0: Expanded Nutrition-focused Physical Exam of the Pediatric Patient. Spurlock, (Dawn) Michele, RDN; Medico, Tegan, MS, MPH, RDN, CNSC; Fay, Elizabeth, MS, RDN, CSPCC, LD. **Support Line; Chicago** Vol. 46, Iss. 4, (Aug 2024): 9-28.

Potential Ethical Tensions

Value or Obligation	Competing value or obligation (perceived or actual)
Maintain trust	Honesty and transparency
Partner with families and older child/teenager	Make recommendations based on evidence and expertise
Protect patient welfare interests	Respect patient/family preferences
Avoid unfair bias or stigma related to malnutrition diagnosis	Ensuring accurate diagnosis and documentation
Address individual needs.	Properly recognizing social determinants of health, inequities, and structural barriers

Guidry-Grimes L, Sowa A, Jankowski J. The Ethics and Practice of Communicating a Malnutrition Diagnosis. *J Acad Nutr Diet*. 2024;124(2):159-163. doi:10.1016/j.jand.2023.10.010

Wrapping Up Exam:

Guidry et al encourages developing a script explaining malnutrition diagnosis or micronutrient concerns with parents/teenagers. Include instructions to follow up with their pediatrician and/or dietitian. Encourage parents to access chart for reminders or concerns and recommendations.

Example 1:
You mentioned that her clothes are looser, and we noted several areas of low fat/muscle, and she does not have the same strength as she did a few months ago. I am concerned about malnutrition. It could simply be that she is growing or that she is more active and needs more. What are your thoughts about this? Are you ok with increasing her tube feeding some? I will follow up with your primary care/GI physician regarding concerns and ensure he/she agrees with this plan. Feel free to access the nutrition note in the chart as a reminder of what we discussed. Do you have any further questions or concerns I can address?

Guidry-Grimes L, Sowa A, Jankowski J. The Ethics and Practice of Communicating a Malnutrition Diagnosis. J Acad Nutr Diet. 2024;124(2):159-163. doi:10.1016/j.jand.2023.10.010

Wrapping Up Exam:

Example 2:
I am concerned with Iron deficiency, a very common issue to toddlers transitioning from breastfeeding/formula to table food Tony has been drinking more than the recommended cows milk amount per day, has had frequent infections and is often feeling tired. Labs indicate very low hemoglobin/hematocrit. Our exam also found pale nail beds, pale conjunctiva (inner eye lids), spoon shaped nails, pale lips/tongue/gums. I am recommending that you start iron supplementation for a few months, then retest. Also, limit cow's milk to less than 2 cups/day; encourage drinking more water and sugar free drinks. Any questions? I will speak to your physician regarding supplementation and retest.

Guidry-Grimes L, Sowa A, Jankowski J. The Ethics and Practice of Communicating a Malnutrition Diagnosis. J Acad Nutr Diet. 2024;124(2):159-163. doi:10.1016/j.jand.2023.10.010

Documentation of NFPE

No consensus.

Document what is seen.

If not symmetrical exam, document exactly which side measured or examined.
Example: MUAC: Left

OR

Example: Unable to complete smile or feel Right side of face.

OR

Only able to assess left arm as other limbs under covers.

Documentation:

Examples:

Simple; quick.

Visually assessed pt.
Reveals: No visible fat/muscle wasting noted at this time.

Visually assessed pt.
Reveals: Visible fat/muscle wasting noted at this time at face, arms, and legs. Flat abdomen.

Visually assessed pt.
Reveals: Visible fat/muscle wasting noted at this time @ temples, square shoulders, ribs and iliac visible, knee prominent, calf minimal bulb.

Documentation

Long standing documentation of physical exams.

Physician example:

Physical Exam
General Appearance: Alert, non-toxic
HEENT: NCAT; PERRL, EOMI; oropharynx clear, moist oral mucosa
Neck: Supple without meningismus; no cervical lymphadenopathy
Respiratory/Chest: No increased work of breathing, symmetric aeration, no wheezes, rales or rhonchi
Cardiovascular: Normal S1, S2, no murmur or gallop.
Gastrointestinal: Soft and non-distended; non-tender. Normal bowel sounds; No guarding or rebound, No hepatosplenomegaly
Musculoskeletal: Normal bulk and strength
Skin: No rashes, petechiae, or purpura
Neurologic: Moves all extremities; normal strength and tone

Documentation:

Muscle/Fat/Function from Pediatric NFPE Handbook

Visually assessed pt.
Reveals: No visible fat/muscle wasting noted at this time.

Orbital: slightly dark circles, somewhat hollow dark circles, hollow depressions, loose/sagging skin
Buccal area: flat cheeks, minimal bounce hollow, sunken cheeks
Upper Arm: some depth pinch, not ample very little space between folds, fingers touch
Thoracic and Lumbar: Ribs apparent with slightly visible depressions between them / Iliac crest slightly visible Progressive prominence of ribs with loss of intercostal tissue/iliac crest very visible
Temple: slight depression hollowing, scooping, depression
Clavicle: visible in males some protrusion in females protruding; shows prominence
Acromion bone: slightly protruding, shoulders not squared Shoulder to arm joints squared, acromion protruding
Scapular bone: mild depression; spine or bone may show slightly prominent, visible scapula, spine depression is significant
Ribs/midaxillary: ribs are apparent with slightly visible depressions between them; iliac crest slightly visible progressive prominence of ribs with loss of intercostal tissue; iliac crest very visible
Dorsal hand: slightly depressed very depressed
Anterior Thigh: mild depression on inner thigh depression line on thigh; obviously thin
Patellar bone: kneecap more prominent; more rounded knee bone prominent; little signs of muscle around the knee
Calf: less developed bulb of muscle thin; little to no muscle definition
Fluid accumulation: mild to moderate pitting; slight swelling deep to very deep pitting ascites per chart
Grip strength: unable to assess weak grasp soft grasp firm grasp strong grasp
MUAC: cm % z-score

Assessment 2.0: Expanded Nutrition-focused Physical Exam of the Pediatric Patient. Spurlock, (Dawn) Michele, RDN; Medico, Tegan, MS, MPH, RDN, CNSC; Fay, Elizabeth, MS, RDN, CSPCC, LD. **Support Line; Chicago** Vol. 46, Iss. 4, (Aug 2024): 9-28.

Documentation:

Micronutrient from Pediatric NFPE Handbook

Micronutrient NFPE:

WNL: Skin, Nails, Hair, Eyes, Oral Cavity, Tongue, Throat.
Skin: no rash. Pale. Non-healing wounds.
Nails: Poor blanching splinter hemorrhages poor nail plate health flaky nails clubbing Koilonychia horizontal grooves/Beau's lines
Hair: alopecia signs of hair thinning or loss various stages of growth lightened hair color corkscrew hair lanugo
Eyes: scaling around the nostrils dry, dull membrane foamy spots/Bitot's spot pale conjunctivae burning/itching eyes with photophobia
Oral cavity: cheilosis angular stomatitis (bilat cracks/redness of lips) spongy, bloody gums mouth lesions dental caries discoloration of teeth inflamed mucosa pale gums
Tongue: beefy red glossitis (magenta color)
Throat: not assessed enlarged parotid (bilat) enlarged thyroid

Add other concerns seen. Delete not needed. OR Bold concerns. Great for EMR.

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Competency

1. Encourage to do regularly. Ask family and friends if may practice.
2. Perform exams with your team, nurses, physicians (including Residents!).
3. Take any NFPE or micronutrient related education.
4. Stock your library with books and pocket guides on NFPE.
5. Discuss cases or literature with other pediatric/neonatal dietitians.

Teamwork makes the dream work!

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Pediatric NFPE Jeopardy!

Measurements

Weight for length under 2 years.
BMI > 2 years of age.

Pediatric NFPE Jeopardy Answer Board

Measurements

What is the appropriate age for Wt/Lt and BMI?

Pediatric NFPE Jeopardy!

Involve family

Leave anxiety at the door and make a game out of exam.

Pediatric NFPE Jeopardy Answer Board

Involve family

What is reducing barriers?

Pediatric NFPE Jeopardy!

Milestones

Physical or behavioral signs of development of infants and children.

Pediatric NFPE Jeopardy Answer Board

Milestones

What are the Early Developmental Milestones?

QUESTIONS

Future Directions

Establishing and maintaining competency.

Which screening tools and body composition to use with which populations?

Update and validate tools and guidelines in pediatric NFPEs for children with complex medical conditions, prematurity, obesity, and history of trauma.

How to incorporate radiologic findings

Increase education on neurologic findings in pediatrics

Encourage case studies of complex malnutrition and micronutrient deficiencies in neonates/children.

Increase accessibility of body composition tools and standards

Clarify laboratory standards (normal, deficiency, toxicity values and treatments guidelines

Validate TMI, grip to BMI ratio and other measures for pediatrics.

Recap

1. Review history and identify nutrition issues.
2. Interview parents and child/teenager, leaving anxiety at the door.
3. Increase your knowledge base on all ages and their developmental milestones.
4. Examine through nutrition kid friendly glasses. *Invite other dietitians, residents and physicians! Ask if able to watch other's exams.*
5. Document findings and diagnosis.
6. Discuss and communicate findings and recommendations with parents, teenagers and team. Collaborating as needed.
7. Refer to outpatient for follow up and/or other specialists, as needed.

"I am always doing that which I cannot do, in order that I may learn how to do it."
Pablo Picasso