musc Children's Health
Medical University of South Carolina

Feeding and Growth in Children

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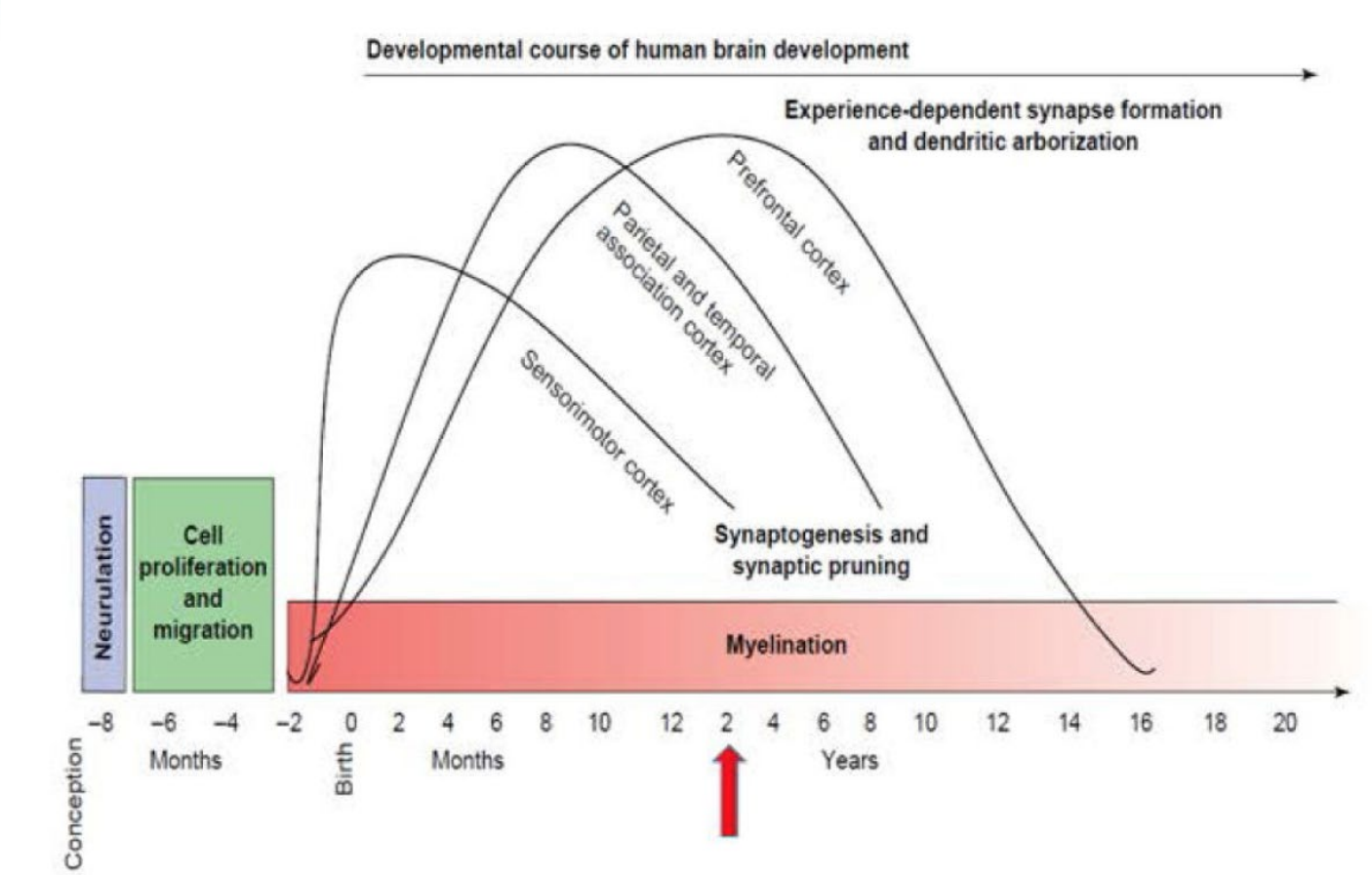
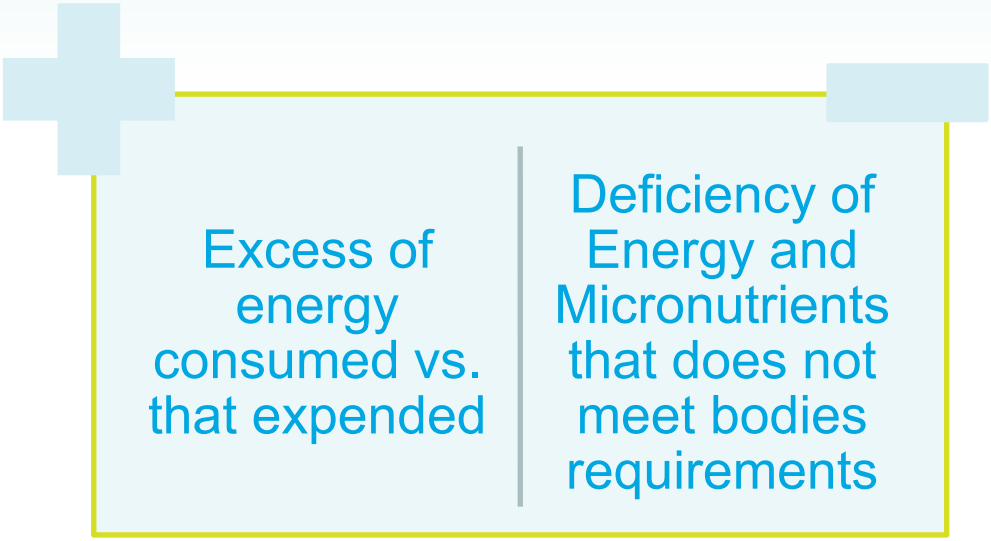
Objectives

- Understand the importance of nutrition early in a child's life.
- Describe a typical diet for infants, toddlers, and adolescents and common feeding or nutrition issues in these age ranges.
- Understand a z-score and its relationship to growth chart percentiles.
- Identify common growth patterns (stunting, wasting, endocrine dysfunction, channeling) based upon a patient's growth chart.

Nutrition in the First 1000 Days: Society's Greatest Opportunity



Origin of Nutrition Related Health Consequences



- Appears to be 2 modifiable risk factors: diet and exercise
- Timing of nutritional imbalances in specific periods of the life cycle, and the environmental, behavioral, social, and economic context in which these happen can complicate the problem
- The answer is much more complex

Relationship Between Early Life Events and Long-Term Consequences

- The Developmental Origins of Health and Disease (DOHaD)
  - Permanent structural and functional changes, during gestation, result in disease later in life
- Nutritional Programming
  - Process and mechanisms by which nutrition related dietary intake and behaviors and environment during pregnancy and the first two years determine health and risk of disease later in life
    - Prenatal influences
    - Breastfeeding and complementary foods

Key Long-Term Outcomes

Neurodevelopment

- Protein-energy malnutrition & specific micronutrient deficiencies cause irreversible damage
- Stunting, Susceptibility to infection, Diminished capacity to learn, poor school performance, and loss of earning potential
- Epigenetic modifications of critical structural and functional genes coinciding with period of peak brain growth

Obesity and CV Disease

- Maternal and gestational nutritional events
- Diets high in energy, excess protein, sugar, sodium, and saturated fat
- Inappropriate metabolic responses, changes in body composition, and increased risk of overweight, obesity, and NCDs

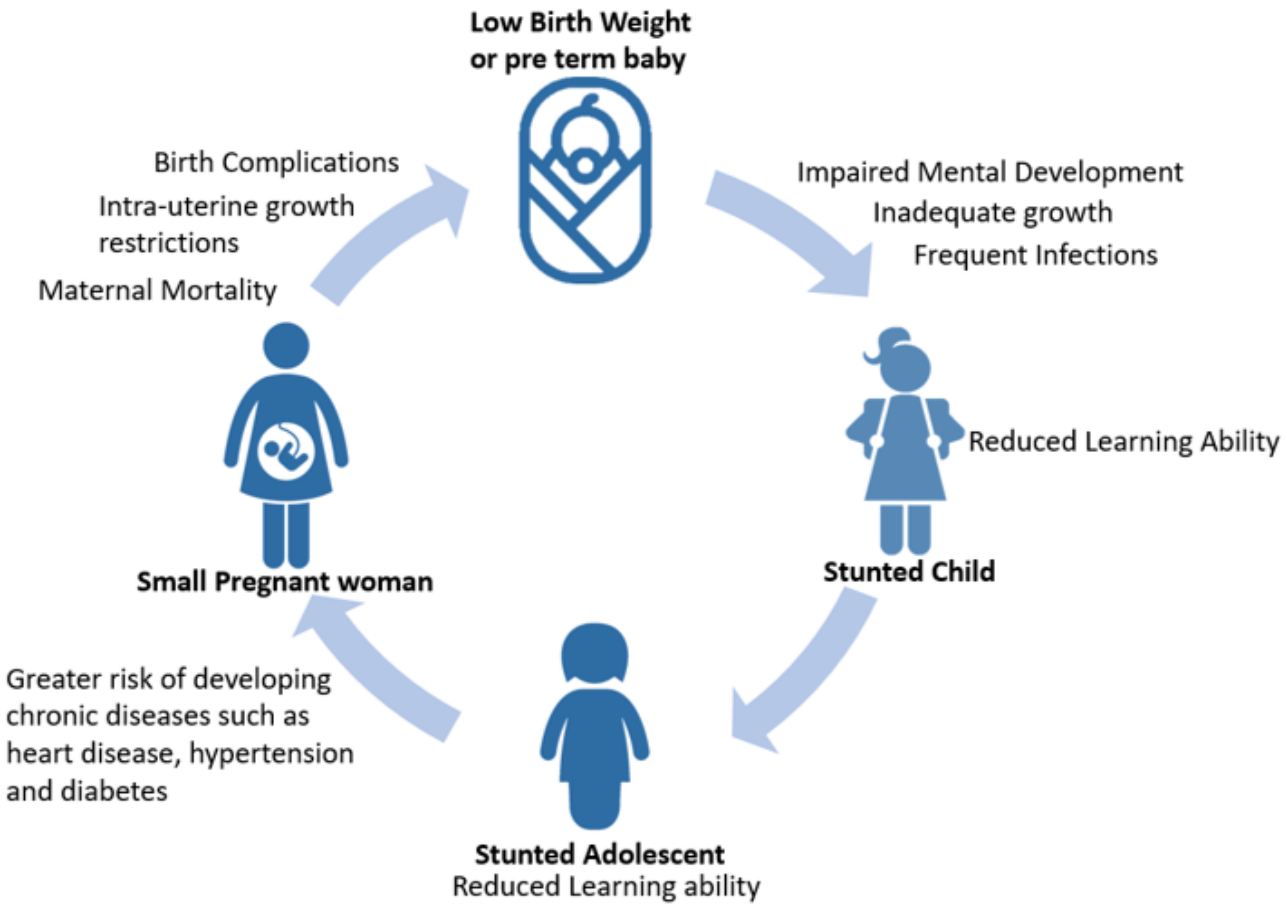
Allergy and Immune Disorders

- Foods are the most common allergens for infants
- Early development of allergy-related conditions is strongly associated with subsequent development of other allergies in later life
- Early introduction may in fact promote the development of tolerance to potential allergenic foods, namely egg and peanut.

The First 1000 Days

- Difficult to recover from these early effects and deficits later in life
- The early years are a period of remarkable plasticity in humans, which allows programming of
  - Metabolic
  - Immunologic
  - Cognitive functions
  - Behavioral and dietary intake patterns
- Shaped by parents and caregivers who need education in nutrition at multiple levels
- Stressed by the pediatric and maternal health providers

Impact of Poor Nutrition Can Transcend Generations

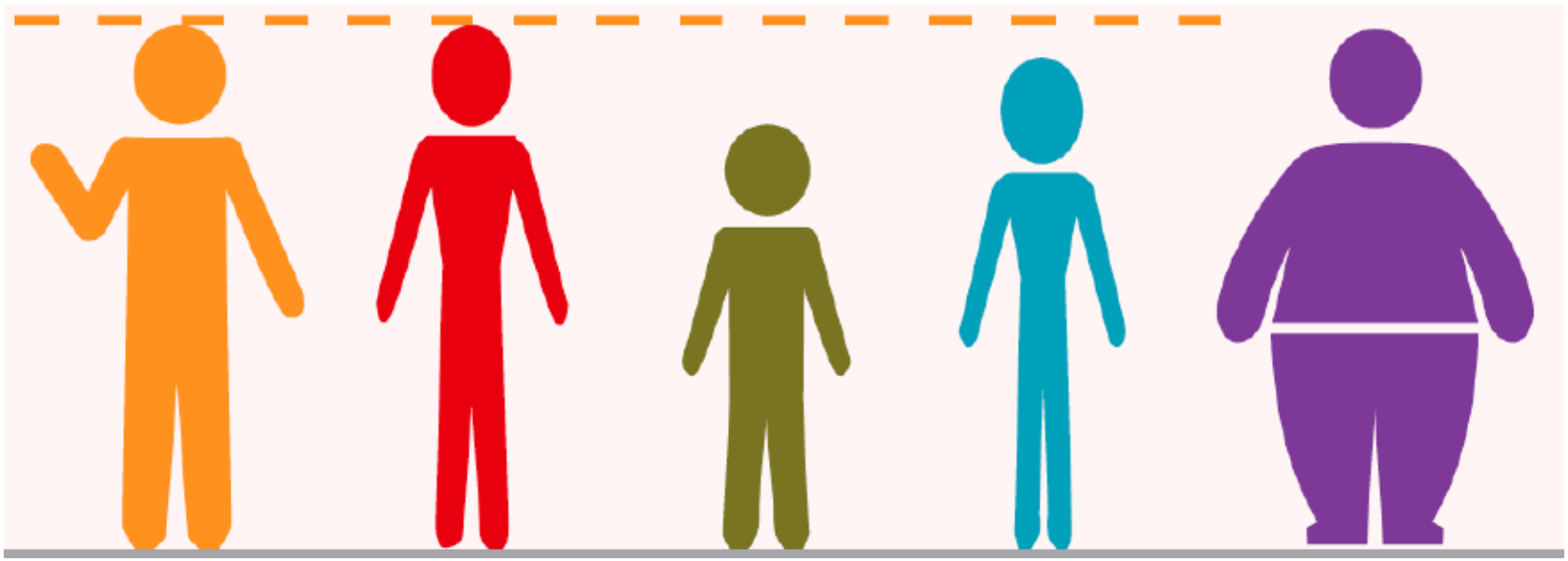


SOURCE: Concern Worldwide, https://www.concernusa.org/story/what-is-stunting/

Types of Malnutrition

1. Undernutrition
   - Wasting
   - Stunting
   - Underweight
2. Micronutrient-related malnutrition
   - Iodine
   - Vitamin A
   - Iron
3. Over nourishment
   - Diet related non-communicable diseases such as DM and heart disease

Patterns of Growth in Children



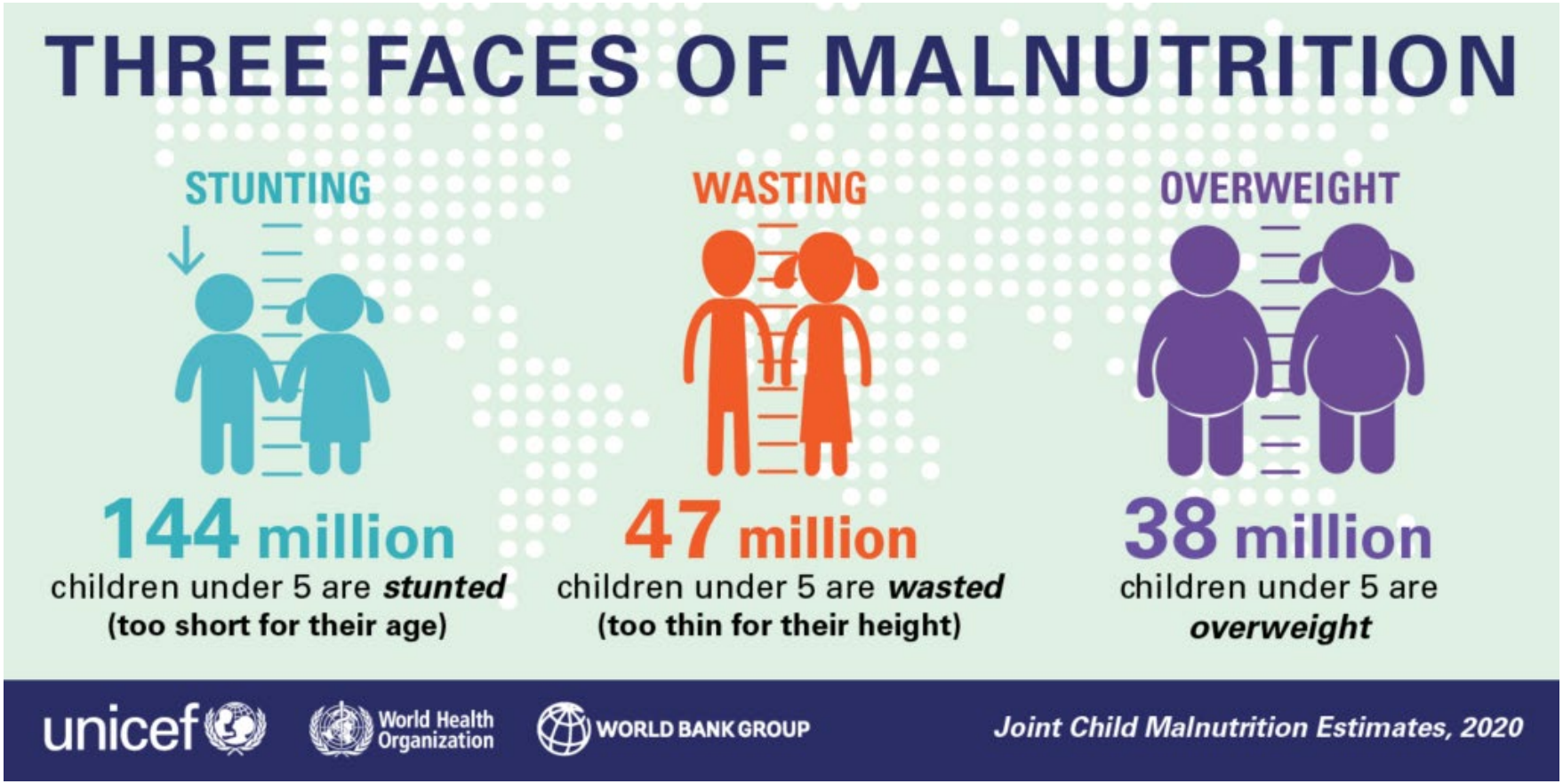
Normal

Wasting

Stunting

Underweight
For Age

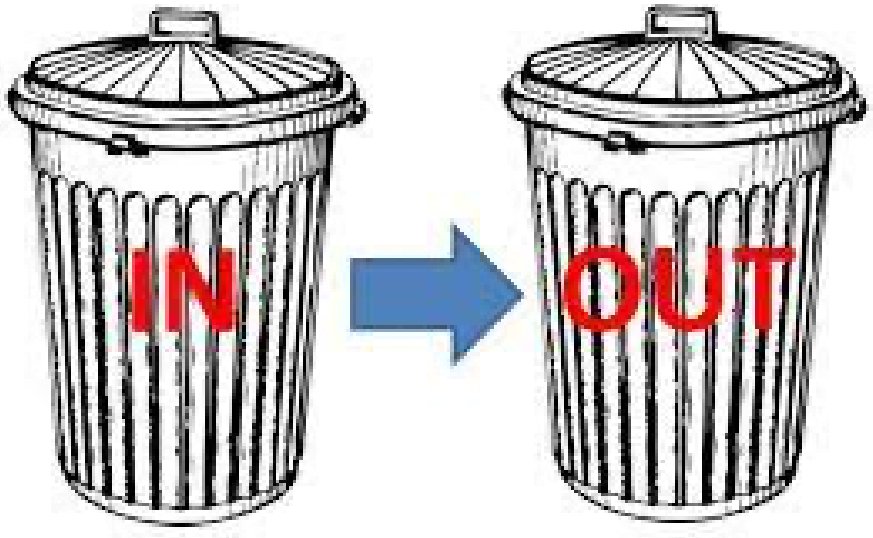
Overweight/
Obesity



The impacts of stunting are largely irreversible after a child's first 1000 days.

Nutrition is a SCIENCE, not an opinion

- Examine the relationship between diet and health
- Harm is done if diet is not optimized, children are vulnerable



Clinical Nutrition 'Lingo'

- Dietary intake is measured in calories (kilocalories, kcal)
- Everyone is measure in kilograms (kg)
  - How many lbs in 1kg?
- Ounces are often used to describe caloric concentration of fluid or total volume for a day
  - How many mls in an ounce?
  - How many kcals in 1 ounce of whole milk?
- Nutrition and fluid is reported in kcals or mls per kg per day
  - Kcal/kg/day
  - ml/kg/day
- Percentiles and z-scores
  - To describe a child's place and movement on a growth chart

Energy, Fluid, Nutrient Requirements

- Energy Requirements are dynamic in first few years of life
  - Infants: 110 kcal/kg/day
    - 3.6kg infant: ~400kcals
  - Ages 15+: 40-45 kcal/kg/day
    - 65kg adult female: 2600 kcals
- Fluid Requirements
  - 1st 10kgs: 100 ml/kg/day
  - 2nd 10kgs: 50ml/kg/day
  - Weight above 20kgs: 20 ml/kg/day
- Unique micronutrient requirements

Infant Feeding

Age	Feeding/ Oral Motor Development	Food Types and Textures	Typical Feeding Schedule
0-4 mos	▪ Roots in search of nipple ▪ Sucking and tongue thrusting are reflexes	Liquids: • Breast milk/ formula	▪ Newborn: 1-2 oz q 1-2 hours ▪ 4 months: 4-5 oz q 4-5 hours
4-6 mos	▪ Reflexive suck diminishes ▪ May put things in mouth to practice ▪ Head and neck control needed for solid food introduction	Liquids: • Breast milk/ formula Smooth purees: • Infant cereal • Stage 1 or 2 purees	• 6 months: 5-6 oz ~5 x/day • 1-2 tbsp of solids 1-2 x/day
6-8 mos	▪ Spoon feeding improves ▪ Craves a variety of textures ▪ Tongue moves side to side and thrust disappears ▪ Learns to drink from a sippy cup	• Breast milk or formula • Purees (stage 1-2) • Teething biscuits • Crunchy dissolvable solids	▪ 8 months: 6-7 oz 4-5 x/day ▪ Solids via spoon 2-3 x/day ▪ Finger foods
8-12 mos	▪ Refines biting/munching ▪ Begins to show more efficient chewing ▪ Wants to self feed	• Breast milk or formula • As above, plus • Soft well cooked vegetables, ground meat	• As above with progress towards longer intervals in feeding and gradually more solids

Nutrition Concerns in Infants

- Vitamin D Deficiency
  - Deficiency can cause rickets
  - Role for vitamin D in maintaining innate immunity and preventing diseases such as diabetes and cancer
  - Breastfed and partially breastfed infants should be supplemented with 400 IU/day of vitamin D and continued until the infant is weaned to at least 1 L/day or 1 qt/day of vitamin D–fortified formula or whole milk.
  - All non breastfed infants, as well as older children who are ingesting <1000 mL/day of vitamin D–fortified formula or milk, should receive a vitamin D supplement of 400 IU/day.
  - Whole milk should not be used until after 12 months of age.
- Iron Deficiency
  - Term infants have iron stores until 4-6 months of age
  - 4 months of age BF infants should receive iron until introduction of iron rich foods
  - WHO states that iron fortified foods should be introduced first (meat)

Toddler Feeding: Good Luck!

- Toddlers are unpredictable
- Transition from on-demand feeding to regular time-based meals is slow
  - Structured meal and snack time vs. grazing
  - Bottle from sippy cup
- Model behavior
  - Feedback for ‘good’ and ‘bad’ behaviors such as eating veggies and throwing food
- New foods should be introduced at least 10 times

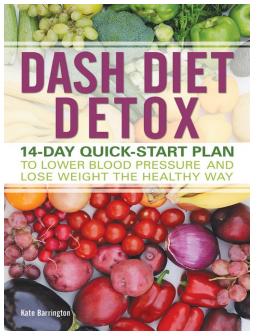
- It is the **parent’s role** to decide the what, where, and when of the meals.
- It is the **child’s role** to decide if, what, and how much to eat.

Nutrition Concerns in Toddlers

- Fat and cholesterol restriction should be avoided in children younger than two years
- Too much milk/dairy
  - At 1 year old no longer need formula, can continue to breastfeed
  - Protein, calcium, vitamin A/D
  - Excess milk is high in calories and low in iron
- Juice
  - Sweetened beverages should be limited to 4 to 6 ounces of 100 percent juice daily
  - 'Substitution effect'

Adolescent Nutrition

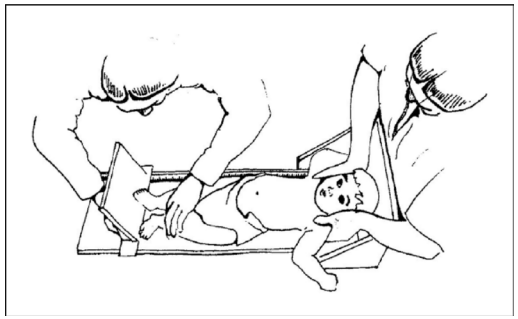
- Diet is comparable to adult's diet
- Most common concerns in adolescent
  - Low consumption of fruits/veggies, whole grains, Ca and low fat dairy
  - Frequent consumption of sugar sweetened beverages and fast foods
- Risk for
  - Fe deficiency anemia
  - Poor bone mineralization
  - Eating disorders
  - Obesity



Measuring Success

Anthropometric Measurements

- Accurate measurements can be elusive
- Stature (cm)
  - Length: 0-24 months
  - Height: 2 years + and able to stand
  - Alternatives for nonmobile patients, equation to extrapolate to a height
    - Tibial length
- Weight (kg)
  - Infant weights often to the gram (ex: 1.525 kg)
  - Older children to kg (22.7 kg)
  - Alternatives
    - Wheelchair scales, bed scales
    - Mid-Upper Arm Circumference (MUAC)
- Head Circumference
  - 0-36 months



Growth Calculations

- Body Proportionality
  - Weight/length < 2 years old
  - Body Mass Index (BMI) if >2 years old
    - BMI= weight(kg)/height (m^2)
  - Graphed in children to achieve a percentile/ z-score
- Mid-Parental Height
  - Patient's height should fall ±8.5cm of mid-parental height

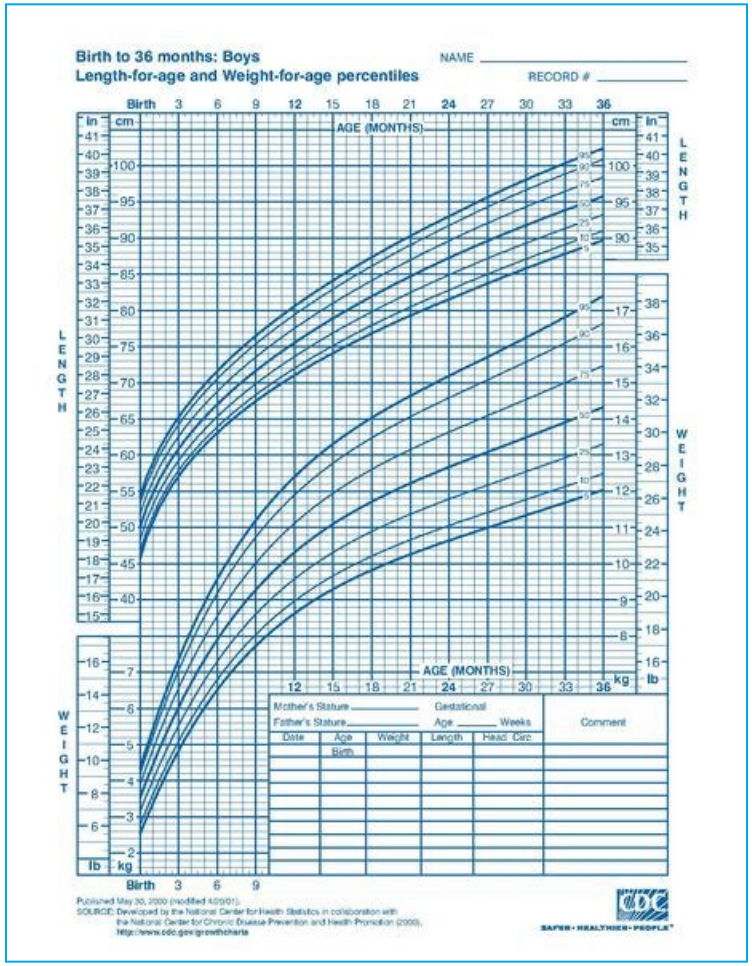
$$\textbf{Girls}: \left(\left[\begin{array}{l} \text{Father's height (cm)} + \text{Mother's height (cm)} \\ -\ 13\ \text{cm} \end{array} \right] /2 \right).$$

$$\textbf{Boys}: \left(\left[\begin{array}{l} \text{Father's height (cm)} + \text{Mother's height (cm)} \\ +\ 13\ \text{cm} \end{array} \right] /2 \right).$$

Components of Growth Chart

- X-axis is age (months/years)
- Y-axis is growth parameter (length, HC, weight, etc)
- Exception is the weight for length curve
- Solid lines represent ‘major percentiles’

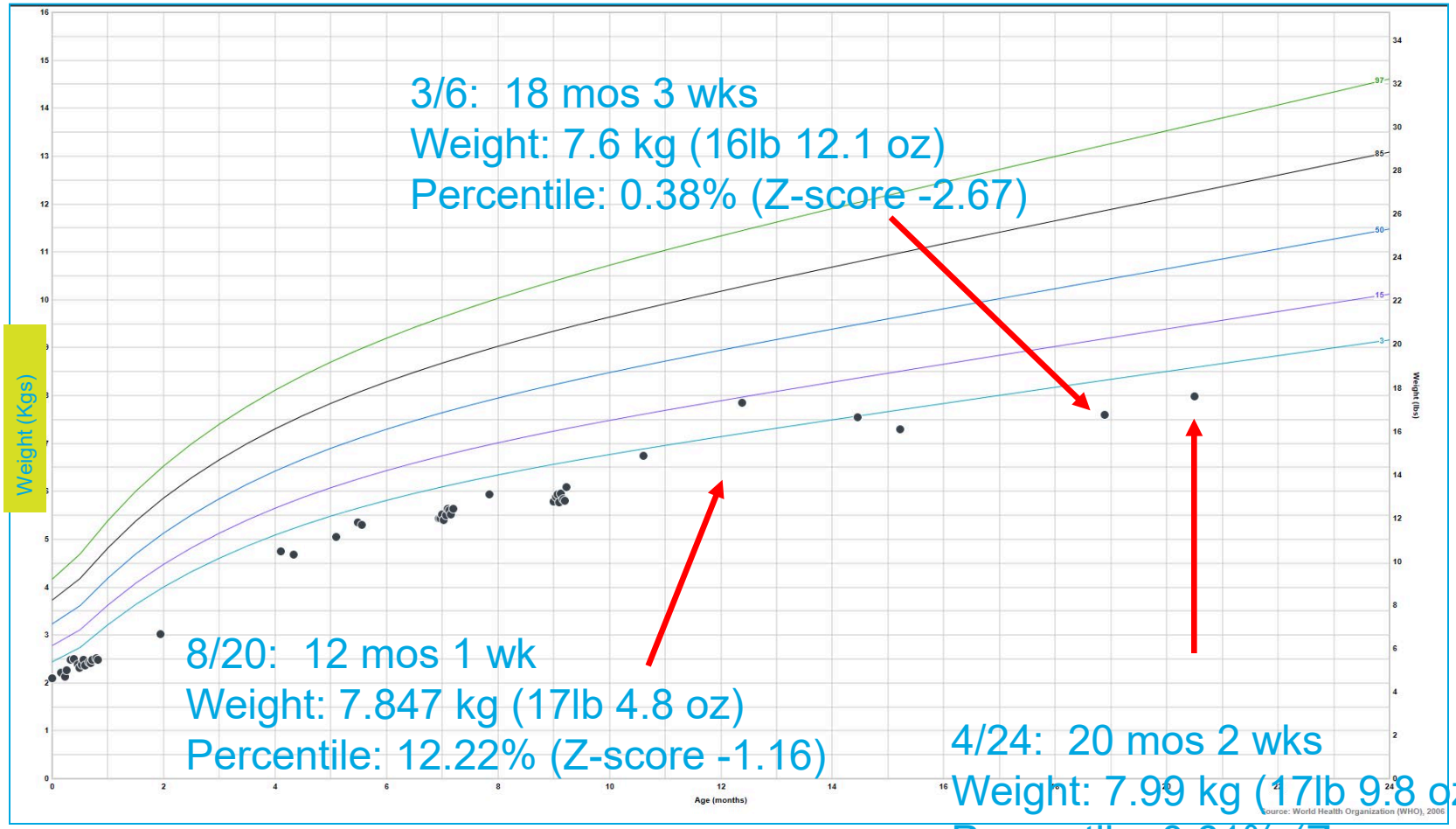
- Interpretation of growth charts is a learned skill
- Best when used to follow longitudinal growth
- A single point on a curve gives you limited information



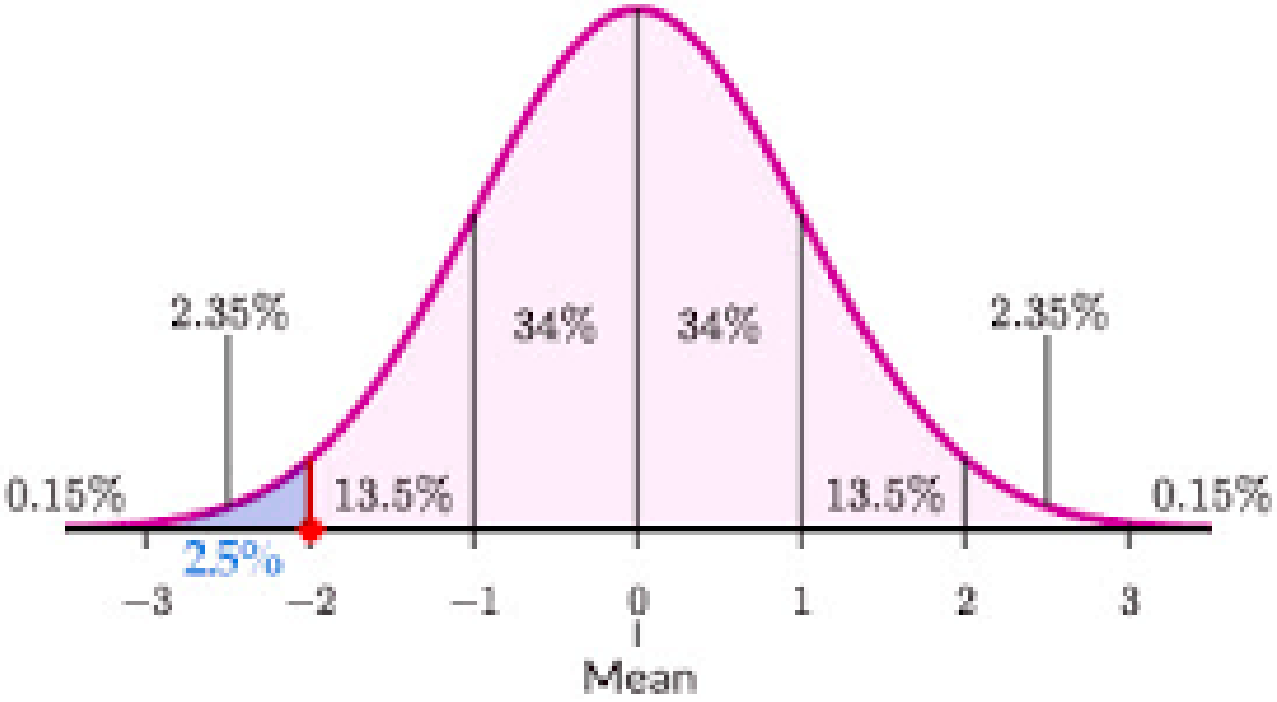
Choosing a Growth Chart

- Infants and children to 2 years of age
  - WHO (World Health Organization)
  - Uses growth of breastfed infant as standard
  - weight for age, length for age, head circumference for age, and weight for length
- 2 years- 20 years of age
  - CDC (Center for Disease Control)
  - Uses height instead of length
  - weight for age, stature for age, and BMI for age

- Specialty Growth Chart
  - Preterm Infants, correction for GA
    - Weight through 24 months
    - Stature through 40 months
    - Head circumference
  - Down syndrome
  - Turner syndrome
  - Cerebral Palsy
  - Prader-Willi
  - Achondroplasia
  - Noonan Syndrome
  - Williams syndrome


3/6: 18 mos 3 wks
Weight: 7.6 kg (16lb 12.1 oz)
Percentile: 0.38% (Z-score -2.67)
8/20: 12 mos 1 wk
Weight: 7.847 kg (17lb 4.8 oz)
Percentile: 12.22% (Z-score -1.16)
4/24: 20 mos 2 wks
Weight: 7.99 kg (17lb 9.8 oz)
Percentile: 0.61% (Z-score -2.51)
Weight (Kgs)
Age (months)
Age (Months)
Weight (lbs)
97
85
50
15
3
Source: World Health Organization (WHO), 2006

Percentiles and Z-Scores



Malnutrition Patterns of Growth in Children

- Wasting: weight for height z-score -2
  - A symptom of acute undernutrition, patient appear thin
- Stunting: height for age z-score -2
  - Stunting is the result of long-term nutritional deprivation and often results in delayed mental development, poor school performance and reduced intellectual capacity.
  - Pattern is wasting → stunting → HC deceleration
- Underweight: weight for age <2 standard deviations from mean (z score -2)
- Overweight: weight for height z-score >+2
  - BMI: overweight 85-95%, obese >95%

Etiologies of Undernutrition in Children

The etiology of poor growth is always 'insufficient usable nutrition'

Inadequate caloric intake	Inadequate absorption	Excessive energy expenditure	Defective utilization
• Improper formula mixing • Inadequate food supply • Neglect	• Vomiting • Malabsorption	• Heart disease • Malignancy	• Metabolic diseases

Failure to Thrive: Describes a symptom not a diagnosis and does not describe well

Nutrition in Practice: Growth Charts

1) Plot on the correct growth chart
2) Ensure accurate measurements and correct transcription onto growth chart
3) Describe the growth chart
   - 'Trending along the x% until age and then….'
4) Describe the most recent growth point
   - 'At the xth% for weight, yth% for height, making him the xth% weight for length (or BMI if >2 years old) and zz% for HC)'
   - System is transitioning to z-scores
5) If possible 'name that pattern': stunting, wasting, overweight, etc.

Growth Chart: Case 1

S.S is a 6.5 year old girl presenting with fatigue. On review of systems she also has cold intolerance, dry skin, and constipation. She looks sick on exam, dry skin, coarse hair. Her mother is 5'2" and her father is 5'7". Mid parental height: 157.3 (17.6%)

Pattern: Endocrinopathy

Labs:

TSH 13pmol/L (elevated), FT4pmol/L: 12 (normal)
Consistent with **hypothyroidism**

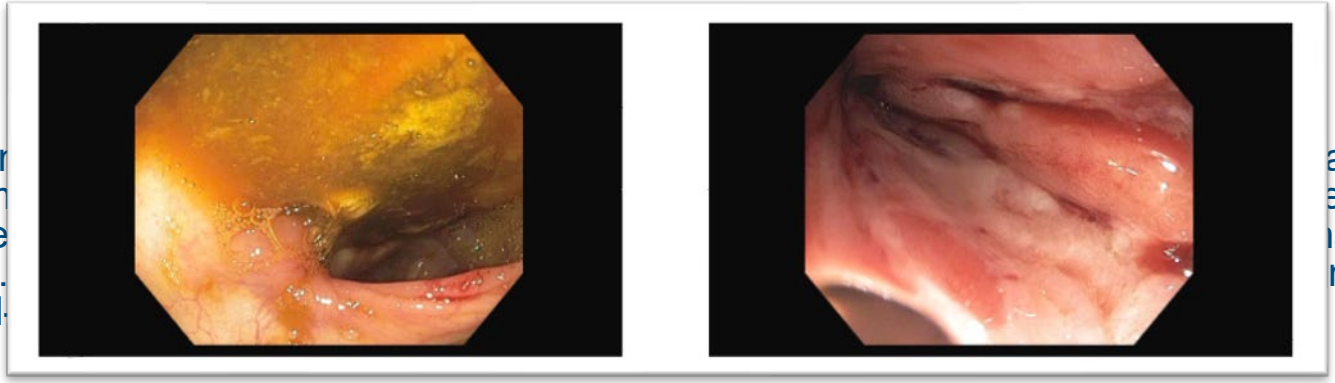
Treatment: Thyroxine

Short Stature/Endocrinopathy

- Mid-parental height provides a rapid and reasonably accurate index of a child's genetic growth potential.
  - Most children achieve an adult stature +/-10 cm of their target height
  - Height percentile differs greatly from target deserves a thorough evaluation to exclude an underlying pathology
- Endocrinopathy (GH< thyroid deficiency, glucocorticoid excess)
  - Preserved weight or obesity in a short child
- Systemic disorders (IBD, CF) STUNTING
  - Greater impairment of weight gain than linear growth
  - Children are thin for their short stature

Growth Chart: Case 2

14 yo fer
Sympton
moveme
fatigued.
She is ill-



arrhea.
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nses.

Pattern: Malnutrition, wasting

EGD: mild duodenitis, esophagus with basal cell hyperplasia
Colonoscopy: chronic colitis in ascending, descending, transverse colon, chronic ileitis, mild duodenitis, esophagus with basal cell hyperplasia

Diagnosis: Crohn's disease

Treatment: Infliximab (anti-TNFα monoclonal Ab) infusions, oral iron, vitamin D, folic acid, zinc supplementation

Wasting

- Weight loss related to
  - Malabsorption of nutrients
  - Increased metabolic demand
  - Chronic caloric insufficiency

- Weight loss will proceed height loss; thin for their height, low BMI

- In IBD there are often other nutritional deficiencies related to inflammation in areas where typical absorption takes place

Interpretation of Growth Charts

- Low weight for age with normal length/height → Inadequate nutrition
  - Some children are small, the 5th% is healthy for some people
- Low length/height for age, 'Short Stature'
  - Low weight gain/month followed by a decrease in linear growth → Inadequate nutrition
  - Weight for length normal with low linear growth → Endocrine or genetic syndrome associated with short stature
- Microcephaly
  - Poor weight gain leading to poor linear growth and poor head growth → Inadequate nutrition

Questions?