REVIEW OF CASE STUDY VIGNETTES OF NUTRITION PROBLEMS IN CHILDREN
Learning Objectives

By the end of each section, you will be able to:

- Assess pediatric patients with nutrition-related conditions such as micronutrient deficiencies and obesity
- Understand the role of a nutrition-focused physical assessment in pediatric clinical practice
- Identify nutritional interventions to address common pediatric nutritional problems in the clinical context
CASE 1

A FOUR-YEAR-OLD CHILD WITH COMPLAINTS OF FEVER, CRANKINESS, AND DECREASED FOOD INTAKE
### Case 1: A four-year-old With Complaints of Fever, Crankiness, and Decreased Food Intake

| Case presentation | • A four-year-old male child was brought to the hospital by his mother with complaints of fever, crankiness, and decreased food intake since three days |
| Past history | • The child was born at term *via* normal delivery, with normal birth weight and without any perinatal complications  
• The child had been exclusively breastfed and had not received any medical care since six weeks of age  
• The family medical history review was non-contributory |
| Clinical examination | • The child was febrile (101°F) and tachypneic (40 breaths/minute)  
• Increasing labored breathing was observed  
• Bilateral crackles were heard |
| Nutrition-focused physical assessment | • Enlarged costochondral junction  
• Swollen and painful wrists  
• Knock knees |
Based on the presentation and findings on initial examination, chest and hand X-rays were ordered. Chest X-ray revealed flaring of the ribs at the costochondral junction and hand X-ray revealed swelling of the wrist joints.

Why do you think a nutrition-focused physical assessment will be beneficial in this child?
Need for Nutritional Assessment

Children compared to adults

- Have lower body fat and muscle mass
- Have higher resting energy requirement/kg body weight
- Are profoundly affected by malnutrition

A complete nutritional assessment is very important in young children because of their higher vulnerability to malnourishment (as compared to adults), which can affect long-term growth and development.

Domains Included in Nutritional Assessment (1/2)

Food and nutrition history

Anthropometric assessments

Biochemical tests/Procedures

Patient / Client history

Physical examination

Components of nutritional assessment

### Domains Included in Nutritional Assessment (2/2)

<table>
<thead>
<tr>
<th>Food/nutrition-related history</th>
<th>Anthropometric measurements</th>
<th>Biochemical data, tests, and procedures</th>
<th>Nutrition-related physical findings</th>
<th>Client history</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obtain data regarding dietary restriction, food allergies/intolerance, eating patterns, and other factors that influence nutrient intake, assess medication, and supplement usage</td>
<td>Obtain and measure height, weight, BMI, circumferences; assess quantity of weight loss and/or gain and velocity of growth/length overtime</td>
<td>Review laboratory and medical test(s) and procedures (for e.g., electrolytes, X-ray, gastric emptying time, and indirect calorimetry) and nutrition-associated medical and surgical history</td>
<td>Use system-based examination of each region of the body to assess physical findings related to nutrition</td>
<td>Obtain pertinent data relating to psychosocial, socioeconomic, and functional behaviors that influence nutrition-related health</td>
</tr>
</tbody>
</table>

BMI: Body mass index.

Subjective and objective data collected within these domains can help in nutrition-related physical assessment.
Defining Nutrition-focused Physical Assessment (NFPA)

- Nutritional assessment determines physical findings via a system-based examination.¹
- Physical changes identified using NFPA include:²
  - Body composition
  - Loss of subcutaneous fat
  - Muscle wasting

Flowchart showing how the nutrition-focused physical assessment (NFRA) fits into the comprehensive nutrition assessment of the Nutrition Care Process (NCP). Details on the remaining three components of the NCP (i.e., nutrition diagnoses, nutrition interventions, and monitoring/evaluation) are beyond the scope of this article.

NFPA: Nutrition-focused physical assessment

Tools/Equipment Needed to Perform NFPA

- Thermometer
- Wooden tongue depressor
- Measuring tape/scale
- Watch
- Stethoscope
- Sphygmomanometer
- Skinfold calipers
- Reflex hammer
- Penlight or flashlight
- Specialized equipment (e.g., ophthalmoscope)

NFPA: Nutrition-focused physical assessment.

## Steps Involved in NFPA

<table>
<thead>
<tr>
<th>Skin</th>
<th>Nails</th>
<th>Head/hair</th>
<th>Eyes</th>
<th>Neck/chest</th>
<th>Musculoskeletal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspect + palpate:</td>
<td>Inspect + palpate:</td>
<td>Inspect + palpate:</td>
<td>Inspect:</td>
<td>Inspect + palpate</td>
<td>Inspect + palpate:</td>
</tr>
<tr>
<td>- Color</td>
<td>- Color</td>
<td>- Quantity</td>
<td>- Changes in vision</td>
<td></td>
<td>- Range of motion</td>
</tr>
<tr>
<td>- Moisture</td>
<td>- Shape</td>
<td>- Distribution</td>
<td>- Color of the conjunctiva and sclera</td>
<td></td>
<td>- Swelling</td>
</tr>
<tr>
<td>- Texture</td>
<td>- Texture</td>
<td></td>
<td>Palpate:</td>
<td></td>
<td>- Fluid accumulation</td>
</tr>
<tr>
<td>- Temperature</td>
<td></td>
<td></td>
<td>- Dryness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Lesions</td>
<td></td>
<td></td>
<td>- Cracks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion Points

- What physical findings are related to vitamin D deficiency?
- What laboratory investigations will you order to further confirm your diagnosis?
Nutrition-focused Physical Assessment of Advanced Rickets

10 Important clinical features in Rickets

- Delayed closure of the fontanelles
- Wide sutures
- Parietal and frontal bossing
- Craniotabes
- Dental hypoplasia
- Pectus carinatum
- Rachitic rosary
- Harrison sulcus
- Swelling in wrist and ankle joints
- Bowing of legs

Laboratory Approach to Diagnosing Rickets

**serum PTH**

- **AP↑, radiographic signs**
  - **Serum PTH**
    - **High**
      - **Serum Ca ↓ or normal, serum P↓ or normal**
        - **Calcipenic Rickets**
          - **25(OH)D**
            - **Normal**
              - **VDDR**
                - **1,25(OH)2D**
                  - **Type I**
            - **Low**
              - **Vitamin D deficiency**
    - **Low**
      - **Type II**

- **Normal**
  - **Serum Ca normal, serum P↓**
    - **Phosphopenic rickets**
      - **Urinary Ca/Cr**
        - **Normal**
          - **XLH tumor rickets**
        - **High**
          - **HHRH**

**AP**: Alkaline phosphatase, **PTH**: Parathyroid hormone, **Ca**: Calcium; **P**: Phosphate; **25-OHD**: 25-hydroxyvitamin D; **VDDR**: Vitamin-D dependent rickets; **1,25(OH)2D**: 1,25-dihydroxy-vitamin D; **Cr**: Creatinine; **XLH**: X-linked hypophosphatemic rickets; **HHRH**: Hereditary hypophosphatemic rickets with hypercalcuria.

Case Study 1: Cont’d...

### Assessment Findings

#### Laboratory investigations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Reference range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum calcium</td>
<td>8.9 mg/dL</td>
<td>8.8–10.6 mg/dL</td>
</tr>
<tr>
<td>Parathyroid hormone</td>
<td>65 pg/mL</td>
<td>10–55 pg/mL</td>
</tr>
<tr>
<td>Alkaline phosphatase</td>
<td>400 U/L</td>
<td>93–309 U/L</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>3.5 mg/dL</td>
<td>3.3–5.6 mg/dL</td>
</tr>
</tbody>
</table>

- Since the serum calcium and inorganic phosphorous levels were normal, PTH was elevated; calcipenic rickets was suspected.

- Since the most common cause of calcipenic rickets is inadequate dietary intake of vitamin D, a 25-OH vitamin D level was ordered.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Reference range</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-OH vitamin D</td>
<td>1.8 μg/L</td>
<td>4.6–37.4 μg/L</td>
</tr>
</tbody>
</table>
Case Study 1: Management

Diagnosis | Vitamin D deficiency – rickets
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Management | • Child was admitted to the pediatric service for further management of rickets
• Mother was educated on various food sources of vitamin D (see appendix in slides)

The 2016 global consensus statement for the prevention and management of rickets:

“Beyond 12 months of age, all children and adults need to meet their nutritional requirement for vitamin D through diet and/or supplementation, which is at least 600 IU/d (15 μg), as recommended by the Institute of Medicine.”

CASE 2

A CASE OF AN EIGHT-MONTH-OLD INFANT WITH INADEQUATE WEIGHT GAIN
Case Study 2: An Eight-month-old Infant With Inadequate Weight Gain

**Case presentation**
- An eight-month-old male infant is brought to the hospital with concerns of no weight gain and tiredness.

**Past history**
- The child was born after a normal full-term pregnancy and the medical and surgical history is uneventful thus far.

**Family history**
- Both the parents are healthy. The family medical history is not contributory.

**Physical examination**
- Length: 68.4 cm (–1 SD)
- Weight: 7.7 kg (–1 SD)
- Head circumference: 43.3 cm (–1 SD)

**What other physical findings will help you arrive at a diagnosis?**
Case Study 2: Cont’d…

Physical examination cont’d…

- The child is pale and lethargic
- Skin: Pallor (+)
- Conjunctiva: Pallor (+)
- Mouth: Atrophic glossitis

What other relevant questions would you ask the mother, in addition to the physical examination?
## Physical Findings and Possible Etiology in Children

<table>
<thead>
<tr>
<th>Finding</th>
<th>Possible etiology</th>
<th>Finding</th>
<th>Possible etiology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skin</strong></td>
<td></td>
<td><strong>Eyes</strong></td>
<td></td>
</tr>
<tr>
<td>Hyperpigmentation</td>
<td>Fanconi anemia</td>
<td>Microcornea</td>
<td>Fanconi anemia</td>
</tr>
<tr>
<td>Petechiae, purpura</td>
<td>Autoimmune hemolytic anemia with thrombocytopenia, hemolytic-uremic syndrome, bone marrow aplasia, bone marrow infiltration</td>
<td>Tortuosity of the conjunctival and retinal vessels</td>
<td>Sickle cell disease (S and C hemoglobinopathies)</td>
</tr>
<tr>
<td>Carotenemia</td>
<td>Suspect iron deficiency in infants</td>
<td>Microaneurysms of retinal vessels</td>
<td>Sickle cell disease (S and C hemoglobinopathies)</td>
</tr>
<tr>
<td>Jaundice</td>
<td>Hemolytic anemia, hepatitis, and aplastic anemia</td>
<td>Retinal hemorrhages</td>
<td>Chronic, severe anemia</td>
</tr>
<tr>
<td>Cavernous hemangioma</td>
<td>Microangiopathic hemolytic anemia</td>
<td>Edema of the eyelids</td>
<td>Infectious mononucleosis, exudative enteropathy with iron deficiency, renal failure</td>
</tr>
<tr>
<td><strong>Face</strong></td>
<td></td>
<td><strong>Mouth</strong></td>
<td></td>
</tr>
<tr>
<td>Frontal bossing, prominence of the malar and maxillary bones</td>
<td>Congenital hemolytic anemia, severe iron deficiency</td>
<td><strong>Glossitis</strong></td>
<td>Vitamin B12, iron deficiency</td>
</tr>
<tr>
<td><strong>Hands</strong></td>
<td></td>
<td><strong>Spleen</strong></td>
<td></td>
</tr>
<tr>
<td>Hypoplasia of the thenar eminence</td>
<td>Fanconi anemia</td>
<td>Enlargement</td>
<td>Congenital hemolytic anemia, leukemia, lymphoma acute infection, portal hypertension</td>
</tr>
<tr>
<td>Spoon nails</td>
<td>Iron deficiency</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pointers to this case
### Signs of Anemia in Toddlers

- None (most patients are asymptomatic)
- Irritability or pica (iron deficiency)
- Tachypnea, tachycardia, shortness of breath, and palpitations
- Pallor – Conjunctivae, tongue, palm, or nail beds
- Glossitis, flow murmur, and growth delay (iron deficiency)
- Petechiae and bruising – Thrombocytopenia (malignancy)
- Short stature, small head, frontal bossing, hyperpigmented skin, and absent thumbs (Fanconi anemia)
- Splenomegaly (chronic hemolysis and malignancy)
- Papulovesicular lesions on the feet (hookworm)
- Jaundice (Hemolysis)

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Further questioning of the mother revealed the following findings:

| Food/nutrition-related history | • The child was exclusively breastfed for six months.  
|                              | • Subsequently, he was introduced to unfortified soy milk, since the mother had to resume her work as an office assistant and she is a strict vegan.  
|                              | • He is very cranky and fussy during feeding.  
|                              | • He eats mashed potatoes and carrots, but dislikes green vegetables.  
|                              | • The mother has not been giving the child iron supplements as he would get constipated.  
|                              | • He seems to have lost his appetite since the past 2 months. |
Case Study 2: Cont’d…

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Reference range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoglobin</td>
<td>4.8 g/dL</td>
<td>10.5–14.0 g/dL</td>
</tr>
<tr>
<td>Hematocrit</td>
<td>25%</td>
<td>33%–39%</td>
</tr>
<tr>
<td>Mean corpuscular volume</td>
<td>60.2 fL</td>
<td>76.0–90.0 fL</td>
</tr>
<tr>
<td>Mean corpuscular hemoglobin</td>
<td>20 fL</td>
<td>30–34 g/dL</td>
</tr>
</tbody>
</table>

Are these laboratory investigations sufficient to arrive at a diagnosis, or would you like to order any further tests?
# Laboratory Findings in Differential Diagnosis of Anemia

<table>
<thead>
<tr>
<th>Type</th>
<th>Hb</th>
<th>Htc</th>
<th>MCV</th>
<th>Iron</th>
<th>TIBC</th>
<th>% Sat</th>
<th>Fer-ritin</th>
<th>RBC</th>
<th>Re-tic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>I</td>
<td>D</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>B12</td>
<td>D</td>
<td>D</td>
<td>I</td>
<td>I</td>
<td>D,N</td>
<td>I,D,N</td>
<td>N</td>
<td>D</td>
<td>D,N</td>
</tr>
<tr>
<td>Folate</td>
<td>D</td>
<td>D</td>
<td>I</td>
<td>I</td>
<td>D,N</td>
<td>I,D,N</td>
<td>N</td>
<td>D</td>
<td>D,N</td>
</tr>
<tr>
<td>E</td>
<td>D</td>
<td>D</td>
<td>I,N</td>
<td>I</td>
<td>D</td>
<td>N</td>
<td>N</td>
<td>D</td>
<td>I</td>
</tr>
<tr>
<td>Chronic Disease</td>
<td>D</td>
<td>D</td>
<td>N</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>N</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>Chronic Inflammation</td>
<td>D</td>
<td>D</td>
<td>N,D</td>
<td>D</td>
<td>D</td>
<td>D,N</td>
<td>I,N</td>
<td>D</td>
<td>D</td>
</tr>
</tbody>
</table>

D=decreased; I=Increased; N=Normal; MCV: Mean corpuscular volume; TIBC: Total iron binding capacity; RBC: Red blood cells; Hb: Hemoglobin.
Additional laboratory investigations were ordered in view of a strict vegan dietary pattern.

### Additional laboratory investigations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Reference range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum vitamin B12</td>
<td>80 pg/mL</td>
<td>216–891 pmol/L</td>
</tr>
<tr>
<td>Peripheral blood cell morphology</td>
<td>Normocytic hypochromic anemia, marked anisocytosis, mild poikilocytosis, hypersegmented neutrophils, and mild thrombocytopenia</td>
<td></td>
</tr>
</tbody>
</table>
Low HGB level (≤2.5th percentile for age, race, and sex)

Does the child truly have anemia?*
  
  Yes

Are other cell lines affected?
  
  No

What is the MCV?
  
  Low MCV
  Normal MCV
  High MCV

MCV: Mean corpuscular volume; HGB: Hemoglobin; * Hemoglobin levels vary considerably by age, race, and sex; when diagnosing anemia, hemoglobin values should be compared with age-, race-, and sex-adjusted norms. Mild anemia occurring at six to nine weeks of life is consistent with "physiologic anemia" and is not pathologic. Falsely elevated hemoglobin values may occur when measured using capillary samples (e.g. finger or heel "sticks"), particularly when using microhematocrit measurements. Spurious results may also occur with automated counters in the presence of lipemia, hemolysis, leukocytosis, or high immunoglobulin levels.

**Diagnostic Approach to Isolated Anemia in Children: Morphologic Classification (2/2)**

**Low MCV**
- Iron deficiency
- Thalassemia
- Sideroblastic anemia
- Anemia of chronic disease

**Normal MCV**
- Drugs; vitamin B12/folate deficiency; hereditary spherocytosis**
- Review smear†
- Hypersegmented PMNs: B12/folate deficiency
- Spherocytes: hereditary spherocytosis‡

**High MCV**
- Further evaluation and confirmatory tests◊

**Other conditions** include sickle cell disease, immune hemolytic anemia, Diamod-Blackfan anemia, liver disease, hypothyroidism, post-splenectomy anemia, myelodysplastic anemia, myelodysplastic syndromes, or reticulocytosis; † Findings on blood smear may suggest an underlying etiology of anemia, but they are generally not diagnostic. Further confirmatory testing should be carried out to confirm the diagnosis. ‡ Presence of sickle cells indicates sickle cell disease; Howell-Jolly bodies are noted in patients post-splenectomy or asplenia. ◊ Anemia of chronic disease typically presents as a normocytic anemia, but can have low MCV.

Clinical Diagnosis and Case Management

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Iron-deficiency anemia and vitamin B12 deficiency in a child from a vegan family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>The child was admitted to pediatric service for further management.</td>
</tr>
<tr>
<td></td>
<td>The mother was educated on the importance of including animal and/or fortified plant-based foods (for e.g., fortified soy milk, which has vitamin B12, folate, calcium, and vitamin D) in the diet.</td>
</tr>
</tbody>
</table>

Food sources of vitamin B12 are presented at the end of the slide deck.

The World Health Organization recommends home fortification of foods with multiple micronutrient powders to improve iron status and reduce anemia among infants and children.
CASE 3

A FOUR-YEAR-OLD CHILD WITH CONSTIPATION
**Case Study 3: A Four-year-old Child With Constipation**

<table>
<thead>
<tr>
<th>Case presentation</th>
<th>A four-year-old boy is brought to the well-child clinic by his mother. The mother complains that the child is suffering from abdominal pain and infrequent bowel movements.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past history</td>
<td>The child was a full-term infant born by cesarean section as the mother had preeclampsia. There were no other perinatal complications.</td>
</tr>
<tr>
<td>Physical examination</td>
<td>The child was alert. Weight: 24 kg (&gt;99th percentile) Height: 101 cm (25th percentile) BMI: 23.5 kg/m² (&gt;99th percentile) Head circumference: 52.5 cm</td>
</tr>
</tbody>
</table>

The BMI is above the 99th percentile. In your opinion, what focused additional questions, physical exam, and tests are recommended in this child?
Universal Assessment of Obesity Risk

Identification

- Calculate and plot BMI at every well-child visit

Medical risk

- 5th–84th percentile
  - Child history and exam; child growth; parental obesity; family history
  - No laboratory investigations needed

- 85th–94th percentile
  - Laboratory tests as needed

- ≥95th percentile
  - Laboratory tests

Behavior risk

- Sedentary time
- Eating
- Physical activity

Attitudes

- Family and patient concern and motivation

Case Study 3: Cont’d…

| Family history | • Both the parents are working.  
|                | • The father is obese.  
|                | • The mother is not obese  
|                | • The child stays at home with his elderly grandmother. |

| Dietary history | • He was started on semisolid foods when he was five months old and was breastfed 2–3 times/day.  
|                | • The grandmother feeds him 6–8 servings of a 240-mL box of sweetened soy milk per day.  
|                | • He enjoys eating French fries with tomato ketchup and cola drinks.  
|                | • He does not like fruits or vegetables. |

| Behavior history | • He spends most of his time watching television, since the grandmother is scared to send him alone outside to play.  
|                 | • His father takes him to the nearby park occasionally.  
|                 | • The family has a pleasant dinner together in the evening. |
**Case Study 3: Cont’d…**

<table>
<thead>
<tr>
<th>Review of systems</th>
<th>Physical examination</th>
</tr>
</thead>
</table>
| • Non-contributory, except for abdominal pain, stretch marks on the abdomen, and knee pain | • Vital signs: Normal  
• Skin: Presence of acanthosis nigricans and stretch marks on the abdomen  
• Conjunctiva: Normal  
• Nose: Nasal congestion  
• Mouth: Normal  
• Musculoskeletal: Bowing of the legs and flat feet |

- **Stretch marks**
- **Flat feet**
- **Moderate acanthosis nigricans**
- **Bowing of the legs**
# Review of Systems for Weight-related Problems

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Possible causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep problems: Loud snoring or apnea</td>
<td>Obstructive sleep apnea</td>
</tr>
<tr>
<td>Sleep problems: Shorter sleep duration, daytime sleepiness, or restlessness</td>
<td>Disordered sleep</td>
</tr>
<tr>
<td>Shortness of breath; exercise intolerance; wheezing, or cough</td>
<td>Asthma</td>
</tr>
<tr>
<td>Heart burn, dysphagia, regurgitation, chest, or epigastric pain</td>
<td>Gastroesophageal reflux</td>
</tr>
<tr>
<td><strong>Abdominal pain and/or distension, flatulence, fecal soiling/encopresis, anorexia, or anuresis</strong></td>
<td>Constipation</td>
</tr>
<tr>
<td>Right upper quadrant pain/epigastric pain/vomiting or colicky pain</td>
<td>Gall bladder disease, with or without gall stones</td>
</tr>
<tr>
<td>Polyuria and polydyspia</td>
<td>Type 2 diabetes mellitus</td>
</tr>
<tr>
<td><strong>Hip pain, groin pain, thigh pain, painful gait, or waddling gait</strong></td>
<td>Slipped capital femoral epiphysis</td>
</tr>
<tr>
<td>Knee pain</td>
<td>Slipped capital femoral epiphysis/Blount disease</td>
</tr>
<tr>
<td>Foot pain</td>
<td>Disordered sleep</td>
</tr>
<tr>
<td>Nocturia/nocturnal enuresis</td>
<td>Intertrigo attributable to increased skin-to-skin contact with persistent moisture</td>
</tr>
<tr>
<td>Rash/irritations/acne</td>
<td></td>
</tr>
</tbody>
</table>

In view of the initial physical examination findings, what laboratory investigations would you order?

<table>
<thead>
<tr>
<th>System</th>
<th>Findings</th>
<th>Possible explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropometric features</td>
<td>Short stature</td>
<td>Underlying endocrine or genetic condition</td>
</tr>
<tr>
<td>Skin</td>
<td>Acanthosis nigricans</td>
<td>Obesity, insulin resistance</td>
</tr>
<tr>
<td>Skin</td>
<td>Irritation, inflammation</td>
<td>Severe obesity</td>
</tr>
<tr>
<td>Eyes</td>
<td>Papilledema, cranial nerve VI paralysis</td>
<td>Pseudomotor cerebri</td>
</tr>
<tr>
<td>Throat</td>
<td>Tonsillar hypertrophy</td>
<td>Obstructive sleep apnea</td>
</tr>
<tr>
<td>Abdomen</td>
<td>Tenderness</td>
<td>GERD, NAFLD*, gallbladder disease</td>
</tr>
<tr>
<td>Reproductive system</td>
<td>Tanner stage</td>
<td>Premature puberty in &lt;7-year-old white girls, &lt;6-year-old black girls, and &lt;9-year-old boys</td>
</tr>
<tr>
<td>Extremities</td>
<td>Bowing of tibia</td>
<td>Blount disease</td>
</tr>
</tbody>
</table>

* This condition is usually without signs; GERD: Gastroesophageal reflux disease; NAFLD: Nonalcoholic fatty liver disease.
# Recommended Laboratory Evaluation

- For all obese patients plus overweight patients who have risk factors: Lipid profile
- Begin screening at the age of 10 years and repeat at least every two years

<table>
<thead>
<tr>
<th>Routine screening includes</th>
<th>Routine screening does not include</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes: Obtain fasting blood glucose levels; HbA1c (new recommendation from American Diabetes Association trumps original recommendation for fasting glucose)—5.7%–6.4%=“prediabetes [increased risk for DM],” ≥6.5%=DM</td>
<td>Hypothyroidism: Not suspected in child with normal linear growth and absence of specific signs (for e.g., goiter)</td>
</tr>
<tr>
<td>NAFLD: AST/ALT (refer for levels &gt;2x upper limit of normal)</td>
<td>Cushing’s syndrome: Not suspected in child without specific signs (e.g. characteristic fat distribution, short stature, violaceous striae, etc.)</td>
</tr>
</tbody>
</table>

NAFLD: Nonalcoholic fatty liver disease; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase.

# Summary of Blood Tests Recommended for Overweight and Obese Children

## Overweight* | Obesity*
---|---
**Age <10 years** | Lipids every two years | Lipids every two years
**Age >10 years, with no risk factors** | Lipids every two years | Lipids every two years
**ALT/AST** | Lipids every two years | ALT/AST
**Fasting glucose** | Lipids every two years | Fasting glucose

**Age >10 years, with risk factors (e.g. hypertension, smoking, hx T2DM, stroke, or CVD)** | Lipids every two years | Lipids every two years
**ALT/AST** | Lipids every two years | ALT/AST
**Fasting glucose** | Lipids every two years | Fasting glucose

- Specialty weight management programs typically including measuring TSH and A1C.
- Hb A1C and liver function tests may need to be performed regularly.
- No recommendation on 25(OH)D
- Non-fasting labs are practical in underserved (~30% come back for fasting tests)

*Overweight and obesity defined using the CDC growth charts as BMI at 85th–94th and ≥95th percentiles.

## Laboratory investigations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
<th>Reference range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HbA\textsubscript{1c}</strong></td>
<td>4%</td>
<td>5.7%–6.4% (prediabetes)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥6.5% (diabetes)</td>
</tr>
<tr>
<td><strong>Triglycerides</strong></td>
<td>115 mg/dL</td>
<td>32–116 mg/dL</td>
</tr>
<tr>
<td><strong>Cholesterol</strong></td>
<td>150 mg/dL</td>
<td>110–217 mg/dL</td>
</tr>
<tr>
<td><strong>AST</strong></td>
<td>55 U/L</td>
<td>15–50 U/L</td>
</tr>
<tr>
<td><strong>ALT</strong></td>
<td>25 U/L</td>
<td>10–U/L</td>
</tr>
<tr>
<td><strong>Anteroposterior radiograph of lower limbs</strong></td>
<td>Abrupt medial angulation “beaking” of the medial cortical wall of the proximal tibial metaphysis</td>
<td></td>
</tr>
</tbody>
</table>

**Anteroposterior radiograph of lower limb**
Clinical Diagnosis and Management

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Obesity with constipation, Blount’s disease, and flat feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>He was managed appropriately for his constipation with polyethylene glycol, in addition to dietary recommendations (below). He was referred to the orthopedist for possible need of inserts and management of Blount’s disease. The mother was counseled on the importance of weight management. She was educated on preventive strategies: • Limiting consumption of sugar-sweetened beverages and calorie-dense foods • Encouraging consumption of diets with fruits and vegetables • Limiting television and other screen time • Limiting portion size • Increasing physical activity</td>
</tr>
</tbody>
</table>

Nutritional management of pediatric obesity should include a qualitative assessment of the patient’s diet, and interventions should be aimed at significantly reducing energy intake and potentially improving nutrition status.

A complete nutrition assessment is very important in young children because of their higher vulnerability to malnourishment as compared to adults.

Nutritional assessment includes medical history, diet history, medical tests/procedures, biochemical tests, anthropometric measurements, and physical examination.

Nutritional assessment uses critical thinking and observation skills, which help in determining physical findings via a system-based examination.

The assessment involves general physical inspection, vitals, skin, nails, head/hair, eyes/nose, mouth, neck/chest, abdomen, and musculoskeletal changes.
Bibliography (1/2)

   *Diabetes Care*. 2012;35 (S1):S64–71. Available at: 
   http://care.diabetesjournals.org/content/35/Supplement_1/S64.full.pdf+html

2. Barlow SE, Expert committee. Expert Committee Recommendations Regarding the Prevention, 

   209.


   2012.


    (S4):S193.


### Important Sources of Calcium, Phosphorous, Vitamin D, and Iron

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calcium</strong></td>
<td>Dairy products, sardines, oysters, salmon, herring, greens, breast milk, and infant formula</td>
</tr>
<tr>
<td><strong>Phosphorous</strong></td>
<td>Dairy products, fish, legumes, pork, breast milk, and infant formula</td>
</tr>
<tr>
<td><strong>Vitamin D</strong></td>
<td>Cod liver oil, fish, eggs, liver, butter, fortified milk, sunlight, and infant formula</td>
</tr>
<tr>
<td><strong>Iron</strong></td>
<td>Red meat, liver, dried beans and peas, enriched farina, breast milk, infant formula, and infant cereal</td>
</tr>
</tbody>
</table>